

**AR0368**

**FINAL FEASIBILITY STUDY  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA**

**Prepared for:  
Jasco Chemical Corporation  
Mountain View, California**

**May 21, 1992**



**OHM  
Remediation  
Services Corp.**



## OHM Remediation Services Corp.

May 29, 1992

Ms. Rose Marie Caraway  
Remedial Project Manager  
USEPA, Region 9  
Water Management Division  
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Dear Ms. Caraway,

Enclosed please find one (1) copy of the Final Feasibility Study (FS) for the Jasco Chemical Corporation (Jasco) Superfund Site located in Mountain View, California. This document reflects revisions to the Draft FS submitted to EPA by Jasco on March 25, 1991 based on comments received from EPA on January 17, 1992.

If you have any questions concerning this document or the continuing activities at the Site, please contact me at (510) 256-6110 ext. 415 or (916) 928-1819 or Mr. Dan Thomas of Jasco at (415) 968-6005.

Sincerely,

Scott Rice  
Project Manager

cc: distribution list  
Mr. Gary Leinweber, City of Mountain View Fire Dept.

FINAL FEASIBILITY STUDY  
JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA

Prepared by:  
OHM Remediation Services Corp.  
Sacramento, California

On behalf of:  
Jasco Chemical Corporation  
Mountain View, California

May 21, 1992

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY.....</b>	<b>E-1</b>
<b>1.0 INTRODUCTION .....</b>	<b>1-1</b>
1.1 PURPOSE AND ORGANIZATION OF REPORT.....	1-1
1.2 BACKGROUND INFORMATION.....	1-1
1.2.1 Site Description.....	1-1
1.2.2 Site History.....	1-2
1.2.3 Nature and Extent of Target Constituents in Soil.....	1-4
1.2.4 Nature and Extent of Target Constituents in Surface Waters.....	1-7
1.2.5 Nature and Extent of Target Constituents in Groundwater.....	1-8
1.2.6 Target Constituent Fate and Transport.....	1-11
1.2.7 Beneficial Uses of Resources.....	1-12
1.2.8 Baseline Risk Assessment.....	1-14
1.2.9 Applicable or Relevant and Appropriate Requirements (ARARs).....	1-15
<b>2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES.....</b>	<b>2-1</b>
2.1 INTRODUCTION.....	2-1
2.2 REMEDIAL ACTION OBJECTIVES.....	2-1
2.2.1 Soil.....	2-2
2.2.2 Groundwater.....	2-4
2.2.3 Comparison of On-Site Concentrations With Remedial Goals.....	2-4
2.3 GENERAL RESPONSE ACTIONS.....	2-6
2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS.....	2-6
2.4.1 Initial Screening and Elimination of Technologies.....	2-6
2.4.2 Selection of Representative Process Options.....	2-9
<b>3.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES.....</b>	<b>3-1</b>
3.1 GROUNDWATER REMEDIAL ALTERNATIVES.....	3-1
3.1.1 Alternative I: No Action.....	3-3
3.1.2 Alternative II: Discharge to POTW.....	3-4
3.1.3 Alternative III: UV Oxidation.....	3-6
3.1.4 Alternative IV: Liquid Phase Carbon Adsorption.....	3-8
3.1.5 Alternative V: Air Stripping.....	3-10
3.1.6 Alternative VI: Biological Treatment Followed by Carbon Adsorption.....	3-12



## **TABLE OF CONTENTS (cont.)**

<b>3.2 SOIL REMEDIAL ALTERNATIVES.....</b>	<b>3-14</b>
3.2.1 Alternative I: No Action.....	3-15
3.2.2 Alternative II: Off-Site Treatment.....	3-16
3.2.3 Alternative III: Enhanced Biological Treatment.....	3-17
3.2.4 Alternative IV: X-19 Biological Treatment.....	3-19
3.2.5 Alternative V: Excalibur Process.....	3-20
<b>4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES.....</b>	<b>4-1</b>
4.1 GROUNDWATER REMEDIATION ALTERNATIVES.....	4-1
4.2 SOIL REMEDIATION ALTERNATIVES.....	4-3

## **APPENDICES**

### **TABLES FIGURES**

**APPENDIX A - REFERENCES**

**APPENDIX B - SUMMARY OF RESULTS OF ANALYSES OF GROUNDWATER SAMPLES,  
1984 TO 1991**

**APPENDIX C - ENDANGERMENT ASSESSMENT**

**APPENDIX D - DERIVATION OF SOIL CLEANUP STANDARDS**

**APPENDIX E - EXPANDED EXTRACTION SYSTEM CALCULATIONS**

## **LIST OF TABLES**

- Table 1.1 - Maximum Concentration of Target Constituents Detected in Soil Samples, Drainage Swale Area DS-1
- Table 1.2 - Maximum Concentration of Target Constituents Detected in Soil Samples, Drainage Swale Area DS-2
- Table 1.3 - Estimated Quantity of Target Constituents in Former Drainage Swale Area
- Table 1.4 - Estimated Quantity of Target Constituents in Underground Storage Tank Area
- Table 1.5 - Estimated Quantity of Target Constituents in Former Diesel Storage Tank Area
- Table 1.6 - Comparison of Laboratory Results of Groundwater Sampling (1984 to 1991)
- Table 1.7 - Historic Frequency of the Detection of Target Constituents in A-Aquifer Groundwater, 1984 to 1991
- Table 1.8 - Historic Frequency of the Detection of Target Constituents in B(1)-Aquifer Groundwater, 1984 to 1991
- Table 1.9 - Results of Analyses of Discharge Water Samples, Extraction Well V-4
- Table 1.10 - Applicable or Relevant and Appropriate Requirements
- Table 1.11 - Standards, Proposed Standards and Action Levels for Drinking Water Sources, California and Federal Regulations
- Table 2.1 - Soil Remediation Goals for Key Constituents
- Table 2.2 - Groundwater Restoration Goals for Key Constituents
- Table 2.3 - General Response Actions for Soil and Groundwater
- Table 2.4 - Initial Screening of Technologies and Process Options for Groundwater
- Table 2.5 - Initial Screening of Technologies and Process Options for Soil
- Table 2.6 - Selection of Representative Groundwater Remedial Options
- Table 2.7 - Selection of Representative Soil Remedial Options
- Table 2.8 - Analytical Requirements Under NPDES Permit
- Table 3.1 - Evaluation of Final Groundwater Alternatives
- Table 3.2 - Evaluation of Final Soil Alternatives
- Table 3.3 - Documentation of ARARs for Groundwater Remedial Alternatives
- Table 3.4 - Documentation of ARARs for Soil Remedial Alternatives

## **LIST OF FIGURES**

- Figure 1.1 - Site Location Map
- Figure 1.2 - Site Plan
- Figure 1.3 - Existing and Former Structures
- Figure 1.4 - Location of Monitor Wells Installed During Previous Investigations
- Figure 1.5 - Location of Sample Points and Delineation of Drainage Swale Areas
- Figure 1.6 - Distribution of Target Constituents in Former Drainage Swale Area DS-1, 3 to 30 feet
- Figure 1.7 - Distribution of Target Constituents in Former Drainage Swale Area DS-2, 2 to 20 feet
- Figure 1.8 - Former Distribution of Target Constituents in Former Drainage Swale Area DS-3, Area of Interim Soil Excavation, 3 to 30 feet
- Figure 1.9 - Distribution of Target Constituents, Underground Storage Tank Area
- Figure 1.10 - Distribution of Target Constituents, Former Diesel Fuel Storage Tank Area
- Figure 1.11 - Distribution of Target Constituents, Drum Storage Area and Background Area
- Figure 1.12 - Direction of Groundwater Flow in the A-Aquifer
- Figure 1.13 - Distribution of 1,1-DCA in A-aquifer, January 27, 1992
- Figure 1.14 - Distribution of 1,1,1-TCA in A-aquifer, January 27, 1992

## EXECUTIVE SUMMARY

This Feasibility Study (FS) is being performed to develop remedial objectives and identify and evaluate remedial action alternatives for the Jasco Chemical Corporation (JASCO) Site. Previous studies have indicated a need for corrective action to mitigate the impacts of chemical compounds present in Site soil and groundwater. Groundwater is defined as sub-surface water contained in the pore spaces between sediments below the water table. The Site is a chemical blending and repackaging plant located in the City of Mountain View, California and is presently operating. The Site is located in an area previously zoned for industrial use but more recently rezoned to provide for a transition to residential and research and development land-uses.

### E.1 INVESTIGATORY, REMEDIAL AND REGULATORY HISTORY

Soil and groundwater investigations at the Site began in May of 1984 in response to a request from the San Francisco Bay Regional Water Quality Control Board (RWQCB). In August of 1987, the RWQCB issued Cleanup and Abatement Order (CAO) No. 87-094 to Jasco, requiring remedial measures and the preparation of a remedial investigation/feasibility study. In response, JASCO conducted additional soil and groundwater investigations, evaluated remedial alternatives, and implemented several interim soil and groundwater remedial measures.

Interim remedial actions performed to date at the Site include:

- 1) the implementation of a groundwater extraction program within the A-aquifer to remove target constituents from groundwater and to prevent lateral and vertical migration of the target constituent plume;
- 2) excavation and off-site disposal of over 500 cubic yards of soil containing the highest concentrations of target constituents;
- 3) implementation of a runoff collection system to collect rain runoff and prevent percolation of surface water to A-aquifer groundwater;
- 4) removal and disposal of an underground storage tank previously used to store diesel fuel;
- 5) destruction of several dry wells; and
- 6) installation of a leak detection system at the present underground storage tank farm.

On June 24, 1988, EPA proposed the Site for inclusion on the National Priorities List (NPL). The Site was finalized on the NPL on October 4, 1989 with a hazard ranking score of 35.56.

On December 21, 1988, EPA issued Administrative Order (Docket No. 89-01) which specified tasks to be completed by JASCO concerning the investigation and remediation of the Site. In compliance with this Order, JASCO has prepared and implemented the RI/FS and Sampling and Analysis Plan for the Site, completed additional soil and groundwater investigations, and prepared a final Remedial Investigation Report in addition to the interim remedial actions described above.

## E.2 NATURE AND EXTENT OF TARGET CONSTITUENTS

The target constituents detected in soil and groundwater at the Site fall under four main categories: volatile organic compounds, petroleum hydrocarbons, aromatic hydrocarbons and alcohols. The volatile organic compounds detected are predominantly halogenated. Among the most persistent are 1,1-dichloroethane (1,1-DCA), 1,1,1-trichloroethane (1,1,1-TCA), and methylene chloride. The petroleum hydrocarbons detected at the Site fall within the range of paint thinner and diesel fuel. The aromatic hydrocarbons present include benzene, toluene, xylene and ethylbenzene. Because several of the aromatic hydrocarbons as well as diesel fuel have been detected in background samples collected away from potential sources, their presence at the Site does not necessarily reflect an on-site source.

### E.2.1 Soil

Target constituents in soil are limited generally to a former drainage swale area at the northern property boundary along the SP railroad track although some target constituents have been detected in soil in the former diesel fuel storage tank area and in the present underground storage tank area. The soil excavation program conducted in the drainage swale area has removed the soil containing the highest concentrations of target constituents. In the eastern portion of the former drainage swale, surrounding the area previously excavated, target constituents are still present based upon data collected during the Remedial Investigation. In this area, the presence of target constituents in soil extends to the depth of groundwater, or approximately 30 feet. To the west of this area, the presence of target constituents appears to be limited to the upper three feet of soil. The drainage swale area contains approximately 1,100 cubic yards of soil which warrant remedial action due to the presence of target constituents. The estimated total volume of target constituents contained within this area is seven gallons of alcohols and volatile and aromatic hydrocarbons and 127 gallons of petroleum hydrocarbons.

The former diesel storage tank area contains approximately 37 cubic yards of soil which warrant remedial action. The target constituent present in this area are limited to petroleum and aromatic hydrocarbons with a total estimated volume of target constituents of less than 0.5 gallons. Soil from the underground storage tank area was found to contain halogenated volatile compounds, aromatic hydrocarbons and alcohols. The volume of soil within this area is estimated at 1,200 cubic yards although it is likely that only a portion of this volume contains target constituents. The total estimated volume of target constituents within this area is less than one gallon.

### E.2.2 Groundwater

Three water-bearing zones have been identified beneath JASCO during the investigations conducted on-site. These three zones have been identified as the A-, B(1)-, and B(2)-aquifers. A deeper aquifer, the C-aquifer, occurs at a depth of approximately 150 feet below grade (94 feet below mean sea level) and supplies a portion of the area's public water. While the A- and B-level aquifer appear to be hydraulically connected, the C-aquifer is separated from the overlying aquifers in the Mountain View area by a 20- to 40-foot thick clay aquitard or a series of interbedded thinner aquitards. Groundwater flow is to the north-northeast at a gradient of approximately 0.004 ft/ft. The vadose zone lithology at the Site consists of interbedded clay, silt, sandy clay, and sandy silt.

Based on 1991 analyses, nine target constituents were present in A-aquifer groundwater samples. Six of these are halogenated volatile organic compounds (1,1,1-TCA, 1,1-DCA, 1,1-dichloroethane, chloroethane, methylene chloride, vinyl chloride). The remaining target

constituents are petroleum hydrocarbons (both in the paint thinner and diesel fuel ranges) and acetone. The maximum concentrations of these nine constituents in samples collected in 1991 ranged from 0.0064 to 0.65 mg/l (approx. ppm). Target constituent presence is limited to the underground storage tank area, the former drainage swale area and areas immediately downgradient of the drainage swale. Target constituent presence and concentration has decreased since the initiation of the groundwater extraction program.

Based on 1991 analysis of the groundwater, the target constituents within the B(1)-aquifer are limited to 1,1,1-TCA and 1,1-DCA at one location. The concentrations of these constituents are below the State Maximum Contaminant Levels (MCLs). Both the number and concentrations of target constituents have decreased over the past five years suggesting that no vertical migration of target constituents between the A- and B(1)-aquifers is occurring.

Neither the A- or B(1)-aquifer is currently being used or is likely to be used in the future as a drinking water source due to the regional presence of contaminants unrelated to the the presence of target constituents at the Site. A-aquifer groundwater as measured at a well at the Site in 1987 exceeded State and/or Federal secondary standards for total dissolved solids and several major anions and does not meet State criteria as a potential drinking water source. B-aquifer groundwater as analyzed at several sites in the vicinity of the Site was also found to be non-potable. At some locations B-aquifer groundwater was found to contain fecal coliform. In addition, the Santa Clara Valley Water District restricts the use of A- and B-aquifer groundwater to monitoring purposes due in part to concerns over salt water intrusion. Domestic or agriculture uses are prohibited. Because of the presence of several aquitards beneath the A-aquifer and the absence of potential conduits between the upper aquifers and the C-aquifer, vertical migration of target constituents from the A-aquifer to the C-aquifer at the Site appears unlikely.

### E.3 BASELINE RISK ASSESSMENT

An Endangerment Assessment (EA) for JASCO Site was prepared by Jacobs Engineering Group Inc. (Jacobs), an EPA consultant, in August of 1989. Jacobs concluded that the Site does not pose a significant health risk under current land-use conditions. According to Jacobs, significant health risks under future land-use conditions would be limited to the use of A-aquifer groundwater as a drinking water source. Jacobs (1989) estimated that a maximum plausible excess cancer risk of  $4 \times 10^{-3}$  (4 in 1,000) for ingestion and  $6 \times 10^{-4}$  (6 in 10,000) for vapor inhalation would be associated with daily use of groundwater in the A-aquifer for domestic water supply over a lifetime (70 years). As the EA did not take into account the removal of constituent-laden soil from the drainage swale area in 1988, the decline in constituent presence and concentration between 1988 and 1991, or the unlikelihood that the A-aquifer groundwater could be used as a drinking water source, the risks presented in the EA may be greater than the actual risks.

### E.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Potential ARARs for groundwater at the Jasco Site include contaminant-specific ARARs related to the use of groundwater resources for potable water supplies and action-specific ARARs related to the protection of aquifer resources and water treatment systems. The uppermost aquifer beneath the Jasco Site, is not currently used as a water source due largely to high levels of dissolved solids and concerns over salt water intrusion. The primary ARARs relating to groundwater quality are the Federal and State Primary and Secondary Drinking Water Standards. Two State resolutions adopted through the Porter Cologne Water Quality Control Act and administered through the Regional Water Quality Control Board are also applicable to the Site. These resolutions relate to

the maintenance of existing water quality and the criteria used to determine whether an aquifer has a current or potential beneficial use.

Potential ARARs for air emissions at the Site are limited to the Federal Clean Air Act and National Primary and Secondary Ambient Air Standards, the State Air Resources Act and Air Toxics Hot Spots Information and Assessment Act and the Bay Area Management Pollution Control District Rules and Regulations.

EPA has set contaminant-specific standards for Site soils containing target constituents. These standards are based on the potential for target constituents to migrate to A-aquifer groundwater at concentrations exceeding the maximum contaminant level for drinking water. These soil standards assume the A-aquifer is used as a drinking water source. The State has developed criteria to define whether a material is hazardous based upon concentrations of contaminants in a waste. These concentrations are expressed as soluble threshold limit concentrations (STLC) and total threshold limit concentrations (TTLC). While these concentrations do not represent cleanup levels they are applicable to the Site with respect to the treatment and disposal of waste material.

## E.5 REMEDIAL ACTION OBJECTIVES

The remediation action objectives for the protection of human health and the environment at the site are: 1) the restoration of A-aquifer groundwater through the removal of target constituents in groundwater and soil; and 2) the lateral and vertical containment of the plume of target constituents in the A-aquifer. Obtaining these objectives will prevent the ingestion of water containing target constituents in excess of Maximum Contaminant Levels (MCLs) and will prevent a total cancer risk of greater than  $10^{-4}$  to  $10^{-6}$ . Central to these goals is the prevention of vertical migration of target constituents from vadose zone soil and A-aquifer groundwater to underlying drinking water sources (C-aquifer).

## E.6 GENERAL RESPONSE ACTIONS

General Response Actions were then developed for the two media of interest (i.e. soil and groundwater). Each action was evaluated with respect to its ability to achieve remedial action goals either as an separate action or in combination with other actions. The general screening actions that were evaluated for soil and groundwater included:

- o No Action
- o Institutional Actions
- o Collection
- o Containment
- o Diversion
- o Excavation
- o On-Site Treatment
- o In-Situ Treatment
- o On- and Off-Site Discharge
- o Relocation

Those general response actions which were not applicable to Site conditions or could not meet remedial action objectives were eliminated from further evaluation.

## E.7 IDENTIFICATION OF VOLUMES OF AFFECTED SOIL AND GROUNDWATER

The nature and extent of target constituents within the media of concern were evaluated with respect to remedial action objectives. To achieve remedial action goals for soil the presence of target constituents in soil within the former drainage swale and former diesel storage tank areas must be addressed. These areas contain approximately 1,140 cubic yards of soil which warrant remedial action. The presence of target constituents within the underground storage tank area will be addressed after the facility operations are ceased. The number and concentrations of target constituents within the underground storage tank area are significantly lower than in the former drainage swale area. The target constituents detected in soil within this area are similar to those found in the drainage swale and diesel storage tank areas. Technologies successful at remediating soil in those areas should be successful at remediating soil from the underground storage tank area.

To achieve remedial action goals for groundwater, both A-aquifer groundwater quality and the potential for vertical and lateral migration of target constituents within A-aquifer groundwater must be addressed. B-aquifer groundwater quality will not be addressed because no MCLs are exceeded and, as with the A-aquifer, its use as a drinking water source is unlikely.

## E.8 INITIAL SCREENING, ELIMINATION AND SELECTION OF TECHNOLOGIES

Remedial technologies within each response action and process options associated with a given technology were identified and evaluated for technical implementability. Those technologies or process options which could not effectively be implemented were eliminated from further consideration. The remaining process options were evaluated for their effectiveness, implementability, and cost. One process, if possible, was chosen to represent each technology.

For groundwater, the applicable process options selected for each technology are as follows:

<u>Remedial Technology</u>	<u>Process Option</u>
No Action	None
Access Restrictions	Deed Restrictions
Monitoring	Groundwater Monitoring
Extraction	Groundwater Extraction
Off-Site Discharge	Publicly Owned Treatment Works (POTW) Discharge
On-Site Treatment:	
Biological Treatment	Anaerobic/Aerobic
Physical Treatment	Carbon Adsorption
Physical Treatment	Air Stripping
Chemical Treatment	Ultraviolet Peroxidation
In Situ Treatment:	
Biological Treatment	Anaerobic/Aerobic

For soil, the applicable process options selected for each technology are as follows:

<u>Remedial Technology</u>	<u>Process Option</u>
No Action	None
Access Restrictions	Deed Restrictions
Monitoring	Vadose Monitoring
Extraction	Vapor Extraction
Excavation	Excavation of areas known to contain target constituents
On-Site Treatment:	
Biological Treatment	Enhanced Aerobic Treatment and X-19
Biological Treatment	Anaerobic Treatment
Soil Washing	Excalibur Treatment
In Situ Treatment:	
Biological Treatment	Aerobic/Anaerobic
Off-Site Discharge	RCRA Facility

## E.9 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives were developed by combining applicable general response action and process options. A number of alternatives were assembled using different combinations of technologies applied to the different media and areas of concern. These alternatives were assembled to provide a range of appropriate alternatives which address the nine evaluation criteria with respect to remedial action objectives.

The remedial alternatives developed for groundwater and the process options contained in each are:

### Groundwater Remedial Alternative I: No Action

### Groundwater Remedial Alternative II: Discharge to POTW

- o Deed Restrictions
- o Extraction, Equalization and Mixing
- o Off-Site Discharge Under POTW Permit
- o Regular Groundwater and Discharge Monitoring

### Groundwater Remedial Alternative III: UV Oxidation

- o Deed Restrictions
- o Extraction
- o UV Oxidation
- o Polishing Treatment (optional)
- o Regular Groundwater and Discharge Monitoring
- o Off-Site Discharge Under POTW Permit



Groundwater Remedial Alternative IV: Carbon Adsorption

- o Deed Restrictions
- o Extraction
- o Carbon Adsorption (liquid phase)
- o Regular Groundwater and Discharge Monitoring
- o Off-Site Discharge Under POTW Permit

Groundwater Remedial Alternative V: Air Stripping

- o Deed Restrictions
- o Extraction
- o Air Stripping
- o Regular Groundwater and Discharge Monitoring
- o Off-Site Discharge Under POTW Permit

Groundwater Remedial Alternative VI: Biological Treatment

Followed by Carbon Adsorption

- o Deed Restrictions
- o Extraction
- o Ex-Situ Biological Treatment
- o Carbon Adsorption (liquid phase)
- o Regular Groundwater Monitoring
- o Off-Site Discharge Under POTW Permit

The remedial alternatives developed for soil, and the process options contained in each, are:

Soil Remedial Alternative I: No Action

Soil Remedial Alternative II: Off-Site Treatment

- o Deed Restrictions
- o Soil Excavation
- o Off-Site RCRA Treatment and/or Disposal

Soil Remedial Alternative III: Enhanced Biological Treatment

- o Deed Restrictions
- o Soil Excavation
- o Enhanced Biological Treatment
- o On-Site Replacement

Soil Remedial Alternative IV: X-19 Biological Treatment

- o Deed Restrictions
- o Soil Excavation
- o X-19 Treatment
- o On-Site Replacement

Soil Remedial Alternative V: Excalibur Process

- o Deed Restrictions
- o Soil Excavation
- o Soil Washing (Excalibur Process)
- o On-Site Replacement

## E.10 COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the alternatives were then evaluated with respect to the nine evaluation criteria. The nine criteria as defined in the National Contingency Plan and CERCLA Section 121(b) and 121(c) are:

- o Overall Protection of Human Health and the Environment
- o Compliance with ARARs
- o Long-Term Effectiveness and Permanence
- o Short Term Effectiveness
- o Reduction of Contaminant Toxicity, Mobility or Volume
- o Implementability
- o State Acceptance/Support Agency Acceptance
- o Community Acceptance
- o Cost

The following is a summary of this analysis.

### E.10.1 Groundwater Alternatives

**Overall Protectiveness.** Alternative I: No Action would provide no additional protection of human health and the environment beyond the present local restrictions on use of A-aquifer groundwater. Expansion of the existing target constituent plume would occur under this alternative. Alternatives II to V would be protective of human health and the environment because each involves the extraction and treatment of constituent-laden groundwater and the containment of the present constituent plume. Alternatives II to V would equally mitigate significant risks to human health associated with the ingestion of A-aquifer groundwater and the inhalation of groundwater vapors. Alternative II involves off-site treatment of extracted groundwater at the POTW. Alternatives III to V involve an on-site treatment step prior to discharge to the POTW.

**Compliance With ARARs.** Alternative I: No Action would not comply with ARARs as the groundwater would continue to contain target constituents at concentrations exceeding MCLs and the potential for migration of target constituents to potable drinking water sources would remain. Alternatives II to V are expected to provide compliance with ARARs. Alternative II: Discharge to POTW, which has been implemented at the Site since 1987, is expected to comply with the existing permit administered by the City of Mountain View based upon recent discharge data. As of April 1992, permit conditions have been exceeded only four times since the system was implemented in 1987 and have not been exceeded since March of 1991. Alternatives III to V will comply with the existing discharge permit because each would incorporate an on-site pretreatment step prior to discharge. The ability of Alternatives II to V to remediate groundwater to MCLs is dependent upon the implementation of soil remedial alternatives and the design of the extraction system. Alternatives II to V would be equally effective at meeting MCLs as each involves the extraction and treatment of constituent-laden groundwater.

**Long-Term Effectiveness.** Alternative I: No Action would be relatively ineffective at long-term reduction of the magnitude of residual risk. The target constituents present could degrade naturally under this alternative although there would be no engineering control of the process and the alternative would not be a reliable method of remediating groundwater. Alternatives II to V would be expected to provide effective long-term reduction of risks through the removal and treatment of affected groundwater and the containment of the constituent plume. Alternative II: Discharge to POTW is a reliable process that has been in use at the Site since 1987. Alternatives

III to V are reliable processes based upon their application at other sites, however, their reliability under Site conditions would be dependent upon system design. The reliability of the carbon adsorption process utilized under Alternative IV (liquid phase) and potentially under Alternative V (air phase) is dependent in part on the interaction between the loading capacities of the target constituent suite. If implemented, each alternative should undergo a five-year review, both to determine the need for further remediation and to establish the effectiveness of the process.

**Short-Term Effectiveness.** There would be no significant risks to on-site workers during the implementation of Alternative I: No Action although the effectiveness at maintaining community protection would be dependent upon the local restrictions on A-aquifer groundwater use. The implementation protocol for Alternatives II to V would be protective of on-site workers and the community. The only potential environmental impact would be the continued drawdown on the A-aquifer required for groundwater containment. A ten-year action time has been estimated for all alternatives involving groundwater extraction although the actual action time required will be dependent upon the implementation of soil remediation alternatives and the variability of maximum sustainable pumping rates.

**Reduction of Toxicity, Mobility and/or Volume.** Alternative I: No Action would provide for no further reduction of the toxicity, mobility and/or volume of target constituents other than that which would occur through normal attenuation and would not satisfy the statutory preference for treatment. Alternatives II to V would provide a reduction of the total mass and volume of target constituents at the Site through the extraction of affected groundwater. Alternatives II to V would also provide for the reduction of toxicity and mobility of target constituents through the treatment processes each will employ. Alternatives II to V involve a off-site treatment step at the POTW after discharge. All target constituents in extracted groundwater under alternatives III to V would be irreversibly destroyed either in the on-site treatment process (e.g. UV Oxidation) or during the regeneration of materials to which the contaminants were transferred on-site (e.g. carbon adsorption). The statutory preference for use of treatment technologies as opposed to removal and disposal technologies would be satisfied under alternatives III to V and may be satisfied under Alternative II depending upon the POTW process.

**Implementability.** Alternative I: No Action would involve no facility construction and would not affect the ability to implement further actions. Alternatives II to V would be relatively easy to construct and operate. Alternative V: Air Stripping could be more difficult to construct if it were to involve a holding tank and an automated system to hold, treat and discharge wastewater. Under the low flowrates that are expected, however, a flow-through system may be utilized which would be as easy to construct as the other alternatives. Alternative III: UV Oxidation would likely be the most difficult to operate due to the difficulties in fine-tuning the system to maintain optimal system performance. Alternatives II to V would not significantly affect the ease of adding additional treatment processes. Each of the alternatives utilize available technologies supplied by vendors that could provide the required equipment, materials and support.

**State and Community Acceptance.** Each of the alternatives would be feasible to implement from an administrative viewpoint. Alternative I: No Action would likely not be acceptable to the state or the community. Alternatives II to V would be expected to be acceptable to the community at their anticipated scope.

**Cost.** There would be no cost for the implementation of Alternative I: No Action. Of the remaining alternatives, Alternative II: Discharge to POTW would be the least costly to implement with a present worth of \$72,000. This alternative would involve a maximum capital cost of

\$30,000 for the potential installation of additional extraction wells and approximately \$7,000 annually for monitoring and discharge costs. The most expensive alternative to implement would be Alternative III: UV Oxidation with a present worth of \$370,000. Capital costs would be approximately \$186,000 with an estimated annual cost of \$31,000. The present worth of Alternative IV: Carbon Adsorption is estimated at \$236,000. The present worth of Alternative V: Air Stripping is \$118,000. The need for treatment of air-effluent is not anticipated under Alternative V, however, if such treatment is necessary the present worth of this alternative would increase by between \$180,000 and \$200,000.

#### E.10.2 Soil Remediation Alternatives

**Overall Protectiveness.** Alternative I: No Action would provide no additional protection of human health and the environment. Further migration of target constituents in soil could occur. Alternatives II and III would reduce risks to human health at the Site through the removal and treatment of affected soil. A treatability study would have to be conducted to determine the effectiveness of Alternatives IV and V at protecting human health. Alternatives II to V would be protective of the environment because each involves the removal of affected soil as well as measures to prevent further migration of target constituents in soil.

**Compliance With ARARs.** Alternative I: No Action would not comply with ARARs, as the affected soil would remain in place with no treatment. Alternative II: Off-Site Discharge would comply with ARARs. Alternative III: Enhanced Bio-treatment would be expected to comply with ARARs based on the biodegradability and volatility of the target constituents. The ability of alternatives IV and V to comply with ARARs would be determined during the treatability study.

**Long-Term Effectiveness.** Alternative I: No Action would be relatively ineffective at long-term reduction of the magnitude of residual risk. The risks associated with the migration of target constituents to groundwater would remain. The target constituents present could degrade naturally under this alternative. There would be no engineering control of the process and the alternative would not be a reliable method of remediating affected soil. Alternatives II to V would be expected to provide effective and permanent long-term reduction of residual risks through the removal of affected soil. Alternatives II, III and IV utilize reliable treatment methods and provide adequate controls. The Excalibur treatment process utilized under Alternative V is a recent development and its reliability is unknown. A five year review would be conducted until soil cleanup standards are met for all areas of the Site.

**Short-Term Effectiveness.** There would be no significant risks to on-site workers under Alternative I: No Action. Dust control may be required during the excavation step of Alternatives II to V to protect against dermal contact and inhalation of dust containing target constituents. No short-term environmental impacts would be expected under alternatives II to V. Under Alternative II: Off-Site Treatment approximately six months would be required to complete the action. Under alternatives III to V, which involve on-site treatment, between one and two years would be required.

**Reduction of Toxicity, Mobility and/or Volume.** Alternative I: No Action would provide for no further reduction of the toxicity, mobility and/or volume of target constituents other than that which would occur through normal attenuation and would not satisfy the statutory preference for treatment. Alternatives II to V would provide a reduction of the total mass, volume and mobility of target constituents at the Site through the excavation, containment and treatment of affected soil. Target constituents in excavated soil under Alternative II: Off-Site Treatment would be irreversibly

destroyed through off-site incineration. Under Alternative III: Enhanced Bio-treatment target constituents would be irreversibly destroyed either during biodegradation or during the regeneration of materials to which the contaminants were transferred on-site (e.g. carbon adsorption). Very low levels of organic constituents may remain in the excavated soil under Alternative III. A treatability study is recommended for Alternatives IV and V to determine their effectiveness at reducing the toxicity, mobility and volume of target constituents in soil. The statutory preference for treatment would be satisfied under alternatives II to V.

**Implementability.** Alternative I: No Action would involve no facility construction and would not affect the ability to implement further actions. Alternatives II to IV would be easy to construct and operate. The ease of constructing and operating Alternative V is unknown because the Excalibur Process was only recently developed. The incineration of affected soil under Alternative II may limit the application of additional actions. Alternatives III to V would not significantly affect the ease of adding additional treatment processes. Alternative II: Enhanced Bio-treatment utilizes available technologies supplied by multiple vendors that could provide the required equipment, materials and support. The number of incineration facilities that could handle Site wastes under Alternative II is limited and only one vendor exists for the X-19 and Excalibur processes under alternatives IV and V.

**State and Community Acceptance.** Each of the alternatives would be feasible to implement from an administrative viewpoint. Alternative III: Enhanced Bio-treatment would meet the substantive requirements for air emissions controls as administered by the Bay Area Air Quality Management District. No air emissions permit will be required. Alternative I: No Action would likely not be acceptable to the state or the community. Alternatives II to V would be expected to be acceptable to the community at their anticipated scope.

**Cost.** There would be no cost for the implementation of Alternative I: No Action. Each of the remaining alternatives include an estimated cost of \$200,000 for the excavation of affected soil. The most expensive alternative would be Alternative I: Off-Site Disposal with an estimated cost of \$1,683,000. Of the alternatives involving on-site treatment, Alternative IV: X-19 Treatment would be the least costly to implement with an estimated cost of between \$278,500 and \$318,500. The estimated cost for Alternative III: Enhanced Bio-treatment would range between \$365,000 and \$448,000 and the estimated cost for Alternative V: Excalibur Treatment would range between \$338,000 and \$470,000.

## 1.0 INTRODUCTION

### 1.1 PURPOSE AND ORGANIZATION OF REPORT

This Feasibility Study (FS) is being performed to develop remedial action alternatives for the Jasco Chemical Corporation (JASCO) Site. The FS provides the basis for selecting the most appropriate alternative to treat soil and groundwater containing target constituents at the Site. Results of the Remedial Investigation (RI) and the Endangerment Assessment (EA) conducted at JASCO have indicated there is a need for corrective action to mitigate the impacts of chemical compounds present at the site on the soil and groundwater. This FS has been prepared by O.H.M. Remediation Services Corp. (OHM) in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as revised by the Superfund Amendments and Reauthorization Act (SARA).

The purpose of the FS is to set remedial objectives that are protective of human health and the environment and to examine remedial technologies which satisfy these objectives. The technologies evaluated in this FS address the control and/or destruction of halogenated solvents and other organic constituents from the soil and groundwater, the reduction of the concentrations of the target constituents to acceptable levels and the prevention of exposure to these constituents. Available technologies are screened and those which are implementable are grouped into remedial action alternatives. The alternatives are examined in greater detail and assessed against the nine criteria set forth in the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (1988).

### 1.2 BACKGROUND INFORMATION

#### 1.2.1 Site Description

The study area includes (1) the real property located at 1710 Villa Street, Mountain View, California, hereafter "JASCO", (2) the property which lies west of JASCO at a distance of approximately 150 feet and north of JASCO at a distance of approximately 275 feet. Figure 1.1 shows the location of the study area with respect to the City of Mountain View. Figure 1.2 shows the study area with respect to local roadways.

The area to the north and west of JASCO includes a portion owned by Southern Pacific Transportation Company (SP) and a portion of the Central Expressway, an east-west transportation corridor through the City of Mountain View as shown in Figure 1.2. The SP portion of the site consists of a 100-foot wide swath wherein two sets of railroad tracks extend in a general northwest-southeast direction connecting San Francisco with San Jose and points south. The Central Expressway, separated from the SP property by a six-foot high chain-link fence, is a four lane expressway with a 20-foot wide center median.

Figure 1.3 depicts the layout of the site and some of the general structures present. Structures include a chemical blending and packaging production area, a warehouse area for inventory, an underground storage tank area, and storage areas for new empty containers and drums.

## 1.2.2 Site History

### 1.2.2.1 Operations

JASCO took possession of the facility in 1976 and has operated the facility as a chemical blending and repackaging plant since this time. Previous to JASCO's operation the facility was operated by West Coast Doors, Inc. a manufacturer of residential and industrial doors. The site is surrounded to the south, west and east by multi-unit residential property and to the north by railroad tracks and property owned by SP.

The site was originally zoned for industrial use. In December of 1985, the Mountain View City Council adopted the Villa-Mariposa Precise Plan. The plan specified changes in land use within the area bounded by the SP railroad tracks, Villa Street, Shoreline Boulevard and the western boundary of the Site; this area includes the JASCO site. The plan dictated the transition of this area from industrial uses to primarily residential and research and development uses. According to this plan, JASCO will have to cease industrial operations by December of 1995.

### 1.2.2.2 Regulatory History

In January of 1983 a resident of the area issued a complaint to the San Francisco Bay Regional Water Quality Control Board (RWQCB) concerning an alleged release of chemicals from the facility. JASCO, at the request of RWQCB, installed three monitor wells at the site between May of 1984 and November of 1986 and submitted results of the soil and groundwater investigations to RWQCB. The locations of the monitor wells are shown in Figure 1.4. On August 3, 1986, the RWQCB issued Cleanup and Abatement Order (CAO) No. 87-094 to Jasco, requiring remedial measures and the preparation of a remedial investigation /feasibility study. To comply with the order, JASCO conducted additional soil and groundwater investigations, installed ten new monitor wells (Figure 1.4), evaluated remedial alternatives, and implemented several interim soil and groundwater remedial measures. The RWQCB eventually referred the site to the EPA.

On June 24, 1988, EPA proposed the site for inclusion on the National Priorities List (NPL) under authority of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The site was finalized on the NPL on October 4, 1989. The hazard ranking score was 35.56.

EPA issued Administrative Order (Docket No. 89-01) on December 21, 1988 which specified tasks to be completed by JASCO concerning the investigation and remediation of the Site. In compliance with this Order, JASCO has prepared and implemented the RI/FS and Sampling and Analysis Plan for the Site, completed additional soil and groundwater investigations including the installation of two additional monitor wells (Figure 1.4), and prepared a final Remedial Investigation Report.

### 1.2.2.3 Interim Remedial Actions

A number of interim remedial actions have been performed on-site to reduce the concentrations of target constituents and to control the migration of target constituents in soil and groundwater.

**Groundwater Extraction Program.** In April 1987, groundwater extraction began from monitor well V-4 and has been in continuous operation since this time. The extracted groundwater

is discharged to the Mountain View sewer system under a permit from the city. The permit allows JASCO to discharge as long as the groundwater does not exceed 1 part per million (PPM) total toxic organic compounds (TTO as defined by 40 CFR 413.02) and does not exceed 0.75 ppm for any one constituent. The permit identified halogenated and aromatic volatile organics as the parameters of concern. Analyses of discharge samples for these constituents are conducted monthly to verify compliance to the permit. Discharge samples are analyzed using EPA methods 601 and 602 on a normal 14-day turnaround from sample collection to the completion of analyses.

The permit requires that JASCO cease discharging immediately if monthly sampling indicates that the discharge does not meet permit conditions. Under such circumstances, the groundwater is resampled and discharge is not continued until permit conditions are met. As of April, 1992 permit conditions have been exceeded only four times since the implementation of the extraction system in 1987 and have not been exceeded since March of 1991. A more detailed description of the groundwater extraction program at well V-4 is included in the Remedial Investigation (OHM, 1991)

The radius of influence of pumping varies with pumping rate. At the maximum observed pumping rate of 2.2 gallons per minute (gpm) well V-4 is capable of containing all groundwater passing across the drainage swale and the northern property border of the Site (Appendix D). At the minimum observed pumping rate of 0.5 gpm, the well is capable of containing groundwater passing across the eastern portion of the drainage swale area which contains the highest concentrations of target constituents. The number and concentrations of target constituents present in groundwater has decreased since the initiation of groundwater extraction (see Section 1.2.5).

**Drainage Swale Excavation Program.** Five hundred seventy-two cubic yards of soil were excavated from the drainage swale area in October and November, 1988. The area of excavation was centered around borehole locations from which soil analyses indicated the highest concentrations of target constituents. The excavation was extended to a depth of between 22 and 28 feet which was the approximate depth of groundwater at that time. The area was excavated by drilling with overlapping large diameter augers and backfilling each borehole with neat cement. The soil was disposed of at the Casmalia Resources Facility in Casmalia, California. A more detailed discussion of the Drainage Swale Excavation Program is included in the Remedial Investigation (OHM, 1991).

**Surface Runoff Collection System.** Following excavation, a surface water runoff management system was installed to prevent further surface water infiltration across the drainage swale. This drainage system is currently in place. Downward percolation of surface water is prevented by a 10-mil thick polyethylene liner. Approximately six inches of fill was placed over the liner and graded to direct surface runoff to a sump which is used to pump the runoff to the sanitary sewer line. A system was also implemented in the front yard area to collect and direct surface runoff to the sanitary sewer system. In association with the implementation of this runoff collection system, three dry wells previously used for runoff collection were destroyed. A more detailed discussion of the Surface Water Runoff Collection System is included in the Remedial Investigation (OHM, 1991).

**Underground Storage Tank Leak Detection System.** In March of 1988 a tracer leak detection system was installed at the underground storage tank system at the western edge of the Site. Tracer chemicals are periodically added to the tank contents. Soil-gas samples are collected monthly from multiple probes located to a depth of 12 feet both within and surrounding the tank farm. Each sample is analyzed for the tracer chemical to verify that no releases have occurred. A



more detailed discussion of the Underground Storage Tank Leak Detection System is included in the Remedial Investigation (OHM, 1991).

**Diesel Storage Tank Removal.** In October of 1987 an underground storage tank at the eastern edge of the Site was excavated and removed. JASCO made periodic use of the tank for diesel fuel storage; however, the tank was inactive at the time of removal. The soil overburden was first excavated by backhoe, then the tank was removed from the excavation. The tank was then thoroughly rinsed on-site and both the tank and rinsate water were transported and disposed off-site. The excavation was then filled with the soil overburden and with fill imported from the truck turn-around area on-site. A more detailed discussion of the tank removal program is included in the Remedial Investigation (OHM, 1991).

**Destruction of Dry Wells.** In April of 1988, three dry wells in the front yard area of the Site were destroyed by redrilling with a large-diameter flight/bucket auger drill rig and pressure grouting with concrete. Drilling was ceased when native soil was reached indicating the bottom of the well. The soil and drain rock removed from the well locations were sampled, profiled and properly disposed at a Class III waste management facility. A more detailed discussion of these measures is included in the Remedial Investigation (OHM, 1991).

### 1.2.3 Nature and Extent of Target Constituents in Soil

The following is a description of the concentrations and distribution of target constituents within each potential source area. Additional information is available in the Remedial Investigation (OHM, 1991).

#### 1.2.3.1. Former Drainage Swale Area

The former drainage swale area has been divided into three areas: DS-1, DS-2 and DS-3 (see Figure 1.5). The vadose zone soil containing detectable concentrations of target constituents is within Areas DS-1 and DS-2. Area DS-3 has been excavated in 1988 in association with the Drainage Swale Excavation Program. For this reason, no further soil remediation within area DS-3 is warranted. The distribution of target constituents within areas DS-1, DS-2, and DS-3 is illustrated in figures 1.6, 1.7, and 1.8.

Area DS-1 is bounded to the north by the ballast of the railroad tracks, to the south by the concrete pad, to the west by borehole SB-5, and to the east by a point approximately 15 feet east of and excludes Area DS-3 which was previously excavated. Target constituents were detected from the ground surface to the top of groundwater within this area. Table 1.1 lists the target constituents which were detected in soil samples collected from this area and the maximum concentrations at which they were detected. Samples collected from the surface to the depth of groundwater at boring C-4 just east of this area (Figure 1.6) did not contain detectable target constituents. The combined surface area of areas DS-1 and DS-3 is approximately 1140 ft<sup>2</sup> (19 feet wide by 60 feet long). The surface area of area DS-3 is estimated at 460 ft<sup>2</sup>. The estimated area of DS-1 is equal to the difference of these two areas or 680 ft<sup>2</sup>. At present the depth to groundwater is 30 feet. Therefore, the total volume of soil within area DS-1 is estimated at 20,400 ft<sup>3</sup> or 755 yd<sup>3</sup> (680 ft<sup>2</sup> X 30 feet).

Area DS-2 encompasses the remainder of the drainage swale stretching 160 feet to the west of area DS-1. The presence of target constituents in this area, with a few exceptions, is limited to a depth of three feet. Table 1.2 lists the target constituents detected in soil samples collected from within

this area and the maximum concentrations at which they were detected. Most maximum concentrations were noted in samples collected at a depth of three feet from locations approximately 30 feet east of the interim soil excavation area. The surface area of area DS-2 is approximately 3,040 ft<sup>2</sup> (19 feet wide by 160 feet long). At a depth of three feet the volume of soil within this area is estimated at 9,120 ft<sup>3</sup> or 340 yd<sup>3</sup> (3,040 ft<sup>2</sup> X 3 feet).

Halogenated volatile organic constituents and petroleum hydrocarbons were detected in all but one of the sample locations within area DS-1. In area DS-2, however, they are generally limited to the southeastern portion, less than ten feet north of the block wall and near to area DS-3.

The lateral distribution of acetone and alcohols extends across the entire length of areas DS-1 and DS-2 (approximately 200 feet). However, the highest concentrations are centered around boreholes SB-9 and SB-10. The lateral distribution of toluene, xylene and ethylbenzene extends across the length of areas DS-1 and DS-2 (approximately 200 feet). In the former drainage swale area benzene was detected only in the near-surface sample from boreholes S-1 and S-2. The presence of benzene at these locations may be unrelated to the activity at the site, as benzene is not used by JASCO in its production operations. Another potential source for the presence of this constituent in the near-surface soil is vehicle traffic from the Central Expressway. Benzene, as well as toluene, xylene, and ethylbenzene, is a common additive to gasoline fuel. A background surface soil sample collected from a point to the north of the SP rail lines (S-6, Figure 1.5) contained ethylbenzene, toluene and xylene at concentrations consistent with those detected in near surface soil from areas DS-1 and DS-2.

Table 1.3 lists the calculated average concentrations and estimated quantities of target constituents within the former drainage swale area, not including DS-3. The average concentration was calculated by dividing the sum of the results of laboratory analyses of all soil samples collected and dividing this number by the total number of samples. These calculations are based upon an estimated 1100 cubic yards of soil within areas DS-1 and DS-2. The estimated quantity of chlorinated compounds in 1100 cubic yards of soil is approximately 0.72 gallons or slightly less than three quarts.

The soil remediation alternatives evaluated in the FS will address the soil within both areas DS-1 and DS-2. The total volume of soil within these two areas is estimated at 1,100 cubic yards.

#### 1.2.3.2 Underground Storage Tank Area

The presence of target constituents in soil in the vicinity of the underground storage tank area is limited to methylene chloride, 1,2-dichloroethane, methanol, acetone, isopropanol and toluene at detectable concentrations ranging from 0.010 mg/kg to 5.8 mg/kg. Concentrations of target constituents present appear to be highest at the northwestern portion of the tank area. At the western boundary of the tank area methylene chloride was detected between the depths of one foot and 20 feet in June of 1987. In November of 1986, acetone, methanol and isopropanol were detected at the northern portion of the tank area between the depths of five and 36 feet. Toluene and 1,2-DCE were detected in samples collected from the eastern portion of the tank area at depths between 20 and 30 feet but the concentrations only slightly exceeded the minimum detection limit of 0.005 mg/kg. The distribution of target constituents within the underground storage tank area is presented in Figure 1.9. The average concentrations of target constituents present in this area are listed in Table 1.4.

The total amount of target constituents estimated to be present at average concentrations is also presented in Table 1.4. The dimensions of the underground storage tank area are approximately 50 feet long by 40 feet wide by 20 feet deep resulting in a volume of approximately 1,480 cubic yards. The total capacity of the existing tank farm is 55,000 gallons or 270 cubic yards. The volume of soil within the tank farm is the difference between the two or approximately 1,200 cubic yards. Because of the limited extent and low concentrations of target constituents in the soil within the underground storage tank area, the volume of soil warranting remediation may be considerably less than 1,200 cubic yards. The estimated total weight of chlorinated compounds in this area is 1.0 pounds or 0.75 pints based upon a total volume of 1,200 cubic yards. The total estimated quantity of all target constituents detected in this area is approximately 0.9 gallons.

Local, state and federal tank closure and hazardous waste regulations will govern the treatment of contaminated soil excavated during tank closure operations. The soil remediation alternatives presented in this FS will not be evaluated with respect to the soil volume within the underground storage tank area because: 1) the extent of target constituent presence is limited; 2) the tank system is currently in use; and 3) a leak detection system capable of detecting leaks in the parts per billion range is in place at the tank area. However, because of the similarities in the constituents present, the technologies found to be feasible for remediation of drainage swale soil will also be applicable to the underground tank area should contaminated soil be identified during tank closure operations.

#### 1.2.3.3 Former Diesel Fuel Tank Area

Analyses of soil samples collected from the excavation at the time of tank removal indicated the presence of total petroleum hydrocarbons as diesel fuel at concentrations between 59 and 360 mg/kg. Benzene, toluene and xylene concentrations ranged from 0.39 to 9.6 mg/kg. Soil samples collected between the surface and the depth of groundwater at downgradient borehole B-7 did not contain detectable concentrations of the constituents, indicating a lack of downgradient migration of these constituents. Methylene chloride was detected in one sample collected at a depth of one foot from this borehole, which is above the level of the former storage tank. The presence of methylene chloride is not likely to be associated with the former storage diesel tank operations.

The distribution of target constituents within the former Underground Diesel Tank Area is presented in Figure 1.10. The average concentrations of target constituents present in this area are listed in Table 1.5. The total amount of target constituents estimated to be present at average concentrations is also presented in Table 1.5. The excavation of the former diesel storage tank encompassed an irregular area equivalent to approximately 100 square feet. The depth of the excavation was approximately 10 feet. The total volume of soil within the former diesel storage tank excavation is 1000 cubic feet or 37 cubic yards. The estimated quantity of all target constituents detected in this area is slightly less than 0.5 gallons.

The soil remediation alternatives evaluated in the FS will address the soil within the former diesel storage tank excavation. The total volume of soil within this area is estimated at 37 cubic yards.

#### 1.2.3.4 Drum Storage Area

The presence of target constituents in soil at the eastern edge of the drum storage area as indicated by samples collected in July, 1990 is limited to benzene, toluene, ethylbenzene and xylene at depths of less than ten feet. Methylene chloride and 1,1,1-TCA had been detected in samples collected from the depths of one foot and 20 feet in June, 1987; however, 1,1,1-TCA was also detected in samples collected from the depths of three and 20 feet at a background location

upgradient of the drum storage area. The presence of 1,1,1-TCA in background samples at similar concentrations and depths as that of the drum storage area samples suggests that the drum storage area is not the source for these constituents. The distribution of target constituents within the drum storage area is presented in Figure 1.11. Because of the limited extent and low concentrations of target constituents, remediation of soil within the drum storage area is not anticipated to be necessary; however, additional soil sampling may be conducted after the facility is decommissioned. Should this sampling indicate that remediation of soil is warranted, the technologies found to be feasible for remediation of drainage swale soil will also be applicable to this area.

#### 1.2.3.5 Background Locations

Soil samples collected from the surface and a depth of one foot at a location to the north of the SP railroad tracks contained detectable concentrations of toluene, xylene, ethylbenzene and methanol. This background data indicates the regional presence of these constituents. This regional contamination has likely contributed to the presence of toluene, xylene, ethylbenzene, and methanol in borehole samples collected within the former drainage swale area. These purgeable aromatic constituents (benzene, toluene, xylene and ethylbenzene) are common components of automobile fuel and the area is used heavily by automobiles and diesel-powered trucks from the Central Expressway.

A near surface soil sample collected from a background location to the south of the drum storage area contained high boiling point hydrocarbons at a detectable concentration consistent with the presence of diesel fuel. Diesel-powered delivery trucks use the area regularly. No target constituents were detected in soil samples collected from deeper depths at this location.

TCA was also detected in the background location south of the drum storage area. This area has never been used in the production operations on-site. The source of TCA in this area may be from surface spillage from adjacent areas or from an upgradient source. It is not likely the drum storage area is the source of TCA, since the drum storage area is downgradient.

#### 1.2.4 Nature and Extent of Target Constituents in Surface Waters

Surface water runoff from property neighboring JASCO is directed to storm sewer lines which discharge to Permanente Creek, located 600 feet west of the site. The storm sewer system, however, does not service JASCO directly. Surface runoff from the front yard area of JASCO flows to the north or northeast and collects near the production building. Surface runoff from the rear yard area collects in the drainage swale area. JASCO has installed a runoff management system at the site which directs all on-site runoff to several concrete sumps. Runoff is then pumped from the sumps to storage tanks on-site before being discharged to the sanitary sewer system through above-ground piping. Groundwater being extracted from well V-4 is being discharged, via above-ground pipes, to the city sewage system and at no time is present as surface water.

Permanente Creek, a concrete-lined engineered drainage channel, is the nearest body of surface water. No other surface water bodies are located within one mile of JASCO. It is not likely runoff from the site has affected bodies of surface water in the area. The remediation of surface water is not applicable to the JASCO site because no surface water bodies are present at the site and on-site runoff is collected and discharged to the sanitary sewer system.

### 1.2.5 Nature and Extent of Target Constituents in Groundwater

Three water-bearing zones have been identified beneath JASCO during the investigations conducted on-site. These three zones have been identified as the A-, B(1)-, and B(2)-aquifers. Another aquifer, the C-aquifer, exists beneath the site. This aquifer, a source of drinking water, is at a depth of approximately 150 feet below grade (94 feet below mean sea level). The vadose zone lithology below the site consists of interbedded clay, silt, sandy clay, and sandy silt.

The A-aquifer, encountered at a depth of approximately 30 to 32 feet (28 feet above mean sea level), is of variable thickness. The A-aquifer is thickest in the vicinity of monitor well I-2 (14.7 feet) and thinnest in the vicinity of monitor well I-3. It is identified at well I-3 only by a soil color change and increase in sand content. The lithology of the A-aquifer is predominantly interbedded sand, gravel, and clay.

The direction of groundwater flow in the A-aquifer as recorded in October of 1987 was 30 degrees east of north (N30E; see Figure 1.12) with a gradient of 0.004 ft/ft (0.004 vertical feet per each linear foot in the direction of groundwater flow). Groundwater flow within the A-aquifer has been affected by the extraction of groundwater from monitor well V-4. Pumping from monitor V-4 has caused the A-aquifer groundwater flow near the well to be deflected towards it. Downgradient of monitor well V-4, A-aquifer groundwater flow appears to be directed along a northeast trending line centered in the vicinity of monitor well V-7. The aquitard separating the A-aquifer and the B(1)-aquifer ranges in thickness from 6.5 feet at well I-1 to 17 feet at well I-2.

The thickness of the B(1)-aquifer ranges from 7.5 feet at well I-2 to 11.2 feet at well I-1. The lithology of this aquifer consists predominantly of silty and gravelly sand. The direction of groundwater flow within the aquifer as of August, 1987 was 15 degrees east of north at a gradient of 0.003 vertical feet per linear foot. The aquitard between the B(1) and B(2)-aquifers was penetrated approximately five feet during installation of the B(1)-aquifer wells. The aquitard contains an abundance of coarse sediments. It is only one foot thick at well I-3. The B(2)-aquifer was apparently penetrated at monitor well I-3. It is 58 feet below grade (one foot below mean sea level). No wells at the site are screened within this aquifer.

There is limited information about the lithology of the soils beneath the B-level aquifers since borings were not taken below the depth of the B-level aquifers. According to a study performed by Harding Lawson and Associates at a group of sites located approximately 1.5 miles east of JASCO, the C-aquifer is generally separated from the overlying B-aquifer by a 20-40 foot thick clay layer or by a series of thinner clay layers (HLA, 1987). The aquitard is laterally continuous and consists of stiff silty clay with lenses of sand. The top of the C-aquifer is located at a depth of 150 feet (94 feet below mean sea level).

#### 1.2.5.1 Target Constituents Within the A-Aquifer

Groundwater samples from the A-aquifer are collected quarterly and analyzed for target constituents. The following target constituents have been detected in groundwater collected from the A-aquifer monitor wells over the four sampling events conducted in 1991:

<u>Halogenated Volatile Organics</u>		<u>Non-Halogenated Organics</u>
1,1,1-TCA	Chloroethane	Acetone
1,1-DCA	Methylene Chloride	TPH as diesel
1,1-DCE	Vinyl Chloride	TPH as paint thinner

The maximum concentrations of these nine constituents in samples collected in 1991 ranged from 0.0064 to 0.65 mg/l. The most recent groundwater sampling phase was conducted in January of 1992. During this phase only eight constituents were detected at concentrations ranging from 0.0029 to 0.61 mg/l. Table 1.6 shows the variation of the maximum concentrations of target constituents in groundwater samples and the frequency at which these constituents were detected since monitoring was initiated in 1984. These data show a marked decrease in target constituent presence and concentration since the groundwater extraction program at well V-4 was initiated. Prior to 1989, 27 constituents were detected in groundwater samples at maximum concentrations ranging from 0.0026 mg/l to 142 mg/l. Table 1.7 shows the frequency of detection of target constituents in groundwater samples collected at each of the A-aquifer wells between 1984 and 1991. Table 1.8 shows the same data for the B(1)-aquifer wells. A more detailed summary of all groundwater analysis since 1984 is presented in Appendix A, Summary of Groundwater Analytical Results. These data are results of analyses of representative groundwater samples collected during previous hydrogeologic investigations or as part of the quarterly groundwater monitoring program. In addition, JASCO's Publicly-Owned Treatment Works (POTW) discharge permit require monthly analysis of discharge wastewater from monitor well V-4. The analytical results for discharge wastewater samples collected during 1990 are listed in Table 1.9.

The distribution of halogenated volatile organic constituents is generally limited to the area near and downgradient of the eastern portion of the former drainage swale area. Of the halogenated volatile organic constituents detected in monitor wells V-1, V-3, and V-4, only 1,1,1-TCA, 1,1-DCA and 1,1-DCE are currently present in downgradient monitor wells at detectable concentrations. The presence of chloroethane and vinyl chloride in A-aquifer groundwater is limited to monitor well V-4 at the eastern portion of the former drainage swale area. The presence of methylene chloride is limited to monitor wells V-1 and V-3 north of the underground storage tank area and well V-4. The distribution of 1,1,1-TCA, 1,1-DCA, and 1,1-DCE is limited to monitor wells V-1, V-3 and V-4 and several downgradient monitor wells. The most recent sampling phase for which laboratory analyses are available was conducted in January of 1992. The only two halogenated volatile constituents which were detected in more than one well during this sampling phase were 1,1-DCA which was detected at wells V-1, V-3, V-4 and V-7 and 1,1,1-TCA which was detected in wells V-4 and V-7. Figures 1.13 and 1.14 show the inferred distribution of these two constituents in A-aquifer groundwater.

The only additional target constituents currently present in A-aquifer groundwater are high boiling point hydrocarbons (present in monitor wells V-1, V-3 and V-4). The occurrence of high boiling point hydrocarbons in wells V-1, V-3 and V-4 has been persistent but in decreasing concentrations over past sampling periods. Since they have not been identified in downgradient wells, this suggests that lateral migration is minimal.

The general chemistry was analyzed for a sample collected from well V-3 in May of 1987. These analyses indicated that the A-aquifer groundwater contained total dissolved solids (TDS) and specific conductance at concentrations of 3,100 mg/l and 3,800 umhos/cm, respectively. The pH was neutral. Hardness was measured at 1,900 mg/l. The concentrations of copper, iron, manganese and zinc were 0.02 mg/l, 0.56 mg/l, 4.5 mg/l and < 0.05 mg/l, respectively. The concentrations of chloride and sulfate were 540 mg/l and 230 mg/l, respectively. Color was measured at 30 color units and the odor threshold number was 6.0. Turbidity was measured at 130 NTU.

#### 1.2.5.2 Target Constituents Within the B(1)-Aquifer

The B(1)-aquifer monitor well network consists of three wells, I-1, I-2 and I-3 (see Figure 1.4). I-1 is constructed in the former drainage swale area. I-2 and I-3 are constructed downgradient of the site. Groundwater from these wells is collected and analyzed quarterly. Based on 1991 analysis of the groundwater, the target constituents within the B(1)-aquifer are limited to 1,1,1-TCA and 1,1-DCA in well I-2. The highest concentrations of 1,1,1-TCA and 1,1-DCA were 3.1 and 2.7 parts per billion (ppb), respectively. These concentrations are below the California Maximum Contaminant Levels (MCLs) of 200 and 5 ppb, respectively. No target constituents have been detected in I-1 or I-3 samples collected in 1990 or 1991 with the exception of phenol, which was detected in a I-3 sample collected in July, 1990, but has not been detected since that time. Table 1.6 summarizes the changes in target constituent presence in B(1)-aquifer wells since 1987. Both the number and concentrations of target constituents have decreased over this period of time. The absence of target constituents in groundwater samples collected from well I-1 since 1990 suggest that there is no current vertical migration of target constituents between the A- and B(1)-aquifers in the vicinity of the drainage swale area.

The B(1)-aquifer is not currently being used as a source of drinking water nor is it likely to be used in the future. A study of the potability of B(1)-aquifer groundwater was conducted at the Middlefield-Ellis-Whisman site (located 1.5 miles east of JASCO) in 1987 (Harding Lawson Associates, 1987). Nearly half of the B(1)-aquifer wells within this study area contained groundwater that exceeded at least one of the established drinking water standards for major anions and many of the wells also contained detectable amounts of fecal coliform (HLA, 1987).

It is unlikely that target constituents could migrate to the C-aquifer in the vicinity of the Site because of: 1) the limited extent and concentration of target constituents in the B(1)-aquifer; 2) the hydrogeology of overlying aquitards; and 3) the lack of potential conduits. No target constituents have been detected in B(1)-aquifer wells at the Site at levels exceeding the maximum contaminant level, the C-aquifer is separated from the B-aquifers in the Mountain View area by a continuous 20- to 30-foot clay layer or a series of interbedded clay layers (HLA, 1987), and no potential conduits have been identified at the Site which penetrate the aquitards beneath the B(1)-aquifer. In order for Site conditions to affect the quality of groundwater in the C-aquifer, target constituents would have to migrate vertically from the A-aquifer through two B-level aquifers and through three aquitards separating the various A, B, and C-level aquifers.

Remediation of the B(1)-aquifer will not be addressed in the FS since: 1) the concentrations detected within the B(1)-aquifer are below the MCLs; 2) the presence of target constituents in the B(1)-aquifer is limited to 1,1,1-TCA and 1,1-DCA in one location; 3) the B(1)-aquifer is not currently used as a source of drinking water; 4) groundwater from numerous B(1)-aquifer wells within a two mile radius of JASCO has been found to be non-potable due to conditions unrelated to the presence of target constituents at the Site; and 5) a continuous 20- to 40-foot thick clay aquitard separates the B-aquifers from the C-aquifer which provides a portion of the local water supply. Monitoring of the B(1)-aquifer will continue for a period of time to assure the concentrations remain below the MCLs.

## 1.2.6 Target Constituents Fate and Transport

### 1.2.6.1 Migration of Target Constituents

Four potential pathways for the migration of target constituents from the site have been identified: vadose zone soil, groundwater, man-made potential conduits and surface and air dispersal.

Migration of target constituents through vadose zone soil at the site has occurred in several areas due to downward migration by gravity of precipitation and surface runoff through vadose zone soil containing target constituents. The presence of root casts and sandy interbeds provide a potential pathway for the vertical migration of target constituents to the A-aquifer. Lateral migration of target constituents in the vadose zone soil has occurred within the continuous coarse sand interbed about 15 feet below grade and along other discontinuous sandy interbeds. In the former drainage swale area and in on-site areas, downward percolation of precipitation and runoff is prevented by the runoff collection system which directs runoff to the local sanitary sewer system thereby minimizing target constituent migration through the vadose zone soil.

Downgradient migration of dissolved halogenated volatile organic constituents in a northerly direction has occurred within the A-aquifer. The stability of the concentrations of target constituents in downgradient monitor wells V-7, V-8 and V-9 suggest that the rate of migration is slow. Migration of target constituents from the drainage swale area appears to be limited to the more mobile chlorinated hydrocarbons such as 1,1,1-TCA, 1,1-DCA, 1,1-DCE and acetone. Less mobile target constituents such as alcohols and petroleum hydrocarbon mixtures have not been detected in monitor wells downgradient from the former drainage swale and underground storage tank areas.

Vertical migration of target constituents between aquifers appears to have occurred as evidenced by the presence of target constituents in groundwater collected from monitor wells completed in the B(1)-aquifer. The presence of these constituents may not be attributed to downward migration through the aquitard separating the A- and B(1)-aquifers as target constituents may have been introduced into the B(1)-aquifer during construction of the B(1) wells. The greatest concentrations of target constituents from monitor well I-1 and I-2 were found immediately after the construction of the wells (August and September, 1987). Concentrations have decreased since this time. No target constituents have been detected in groundwater samples from monitor well I-1 since August, 1987. Concentrations in monitor well I-2 initially decreased and have since stabilized. The absence of target constituents in groundwater samples collected from I-1, less than five lateral feet from extraction well V-4, indicates that there is no vertical migration of contaminants from the A- to B(1)-aquifers in the drainage swale area.

Migration through the aquitard separating the two aquifers is unlikely. A sample of the aquitard collected from a depth of 36 feet from monitor well I-2 was classified as clay (CL) with a vertical permeability of  $3.1 \times 10^{-7}$  cm/sec ( $6.1 \times 10^{-7}$  ft/min). A sample collected from a depth of 28 feet at monitor well I-3 was also classified as clay (CL) with a vertical permeability of  $2.8 \times 10^{-6}$  cm/sec ( $5.5 \times 10^{-6}$  ft/min). Permeability values between  $10^{-8}$  and  $10^{-5}$  ft/min are considered to be low. The lateral continuity of this aquitard both on-site and at downgradient locations was established during the installation of the B(1)-aquifer wells. Lateral movement of target constituents within this aquifer would occur as a slow downgradient (northerly) migration. The presence of target constituents in B(1)-aquifer monitor wells over the past four monitoring phases is limited to 1,1,1-TCA and 1,1-DCA at monitor well I-2. This suggests that there is no downgradient migration of target constituents from potential source areas.



The low permeability of the aquitard underlying the B(1)-aquifer makes vertical migration to underlying aquifers unlikely. Laboratory testing of samples collected from the aquitard indicated the permeability of the aquitard to be  $2.9 \times 10^{-7}$  cm/sec ( $5.7 \times 10^{-7}$  ft/min) to  $2.3 \times 10^{-8}$  cm/sec ( $4.5 \times 10^{-8}$  ft/min).

Lateral and vertical migration of target constituents may have occurred in the past along surface pathways, particularly in the area of the former drainage swale. However, such pathways have been eliminated or significantly decreased. Migration of target constituents along these pathways are unlikely.

The migration of target constituents through air pathways would also be unlikely. Most target constituents are present at depths in excess of two feet, or are relatively immobile due to surface conditions or chemical characteristics.

#### 1.2.6.2 Target Constituent Persistence

The target constituents present at the site can be divided into three categories: halogenated volatile organic constituents, non-halogenated organic constituents and phenolic compounds. The volatile organic constituents identified at the site are generally highly volatile and moderately to highly soluble. These constituents would not be expected to be persistent in near surface soils. At depth and in groundwater they would be more persistent due to their solubility in groundwater, the vadose zone moisture, and their resistance to biodegradation by naturally occurring soil organisms.

The phenolic compounds identified in soil and groundwater at the site tend to be of low to medium solubility and low volatility. These constituents would tend to be very persistent in subsurface soil and groundwater. Their presence at the JASCO site is very limited and at very low concentrations.

The shorter chain petroleum hydrocarbons, which generally include thinners and gasoline, tend to be moderately to highly volatile with low solubility. They are readily biodegradable by naturally occurring soil organisms under aerobic conditions. For these reasons, such constituents would not be highly persistent at shallow soil depths. They would be more persistent in groundwater, as they have a tendency to remain as free product floating on the groundwater surface (no groundwater samples from JASCO has had floating free product).

The longer chain petroleum hydrocarbons (predominantly diesel fuels) are less volatile. They are not as readily biodegradable so tend to be very persistent in subsurface soil and groundwater.

#### 1.2.7 Beneficial Uses of Resources

The current and potential beneficial uses of resources at or near the JASCO Site are limited to land-related and groundwater development uses. There are no surface water or wetlands uses for the JASCO Site.

##### 1.2.7.1 Land-Related Uses

The JASCO Site is currently zoned and operated for light industrial use. The property is bordered to the west, south, and east by land currently used for multi-unit residences. The property is bordered to the north by the Southern Pacific Railway right-of-way and currently used for passenger and freight transport. Within a 1,000 foot radius of the JASCO facility, the land is

currently utilized predominantly for single and multi-unit residences. To the east of the Site, a portion of the land north of Villa Street is used for light industry and offices. To the west at the intersection of Escuela and Crisanto Avenues exists several light industrial properties including an operating dry cleaning establishment.

The JASCO Site falls within the jurisdiction of the Villa-Mariposa Area Precise Plan adopted by the Mountain View City Council on December 13, 1985. This plan provides for the transition of the area to primarily residential uses. Limited office/industrial uses will be allowed to continue to the east of the JASCO Site.

#### 1.2.7.2 Groundwater Uses

Three groundwater aquifers are present beneath the site at a depth of less than 200 feet. Present and potential uses for these aquifers include municipal, industrial, and agricultural uses. The uppermost aquifer, designated as the A-aquifer, occurs at a depth of approximately 30 feet at the Site (28 feet above mean sea level) and varies greatly in thickness to a maximum of 15 feet. The B-aquifer is found at a depth of approximately 47 feet (11 feet above mean sea level). At the Site, this aquifer appears to be represented by two interconnected aquifers which extend to a depth of near 75 feet (approximately 17 feet below mean sea level). The top of the C-aquifer is encountered at a depth of approximately 150 feet (94 feet below mean sea level).

**A-Aquifer.** The potential for the use of A-aquifer groundwater for water supply is limited by yield and water quality. The yield of the aquifer is highly dependent upon groundwater levels, aquifer lithology and well placement. Two of the monitor wells at the site (V-9 and V-10) are nearly dry due to the decrease in the water table elevation over the past four years. In addition, several other A-aquifer monitor wells at the Site are routinely and rapidly purged to nearly dry by bailing during the groundwater sampling phases. The maximum estimated yield, based on pumping data from well V-4 is 3170 gallons per day (2.2 gal/min) although it has yielded at little as 720 gallons per day (0.5 gal/min). At present the yield of this well is between 1440 and 1728 gallons per day (1.0 to 1.2 gal/min).

The total dissolved solids (TDS) in the A-aquifer, as measured in a sample collected from well V-3 in May of 1987 was 3,100 mg/l. This exceeds the 3,000 mg/l level used by the State of California to define suitable or potentially suitable water resources (State Water Resources Control Board, Resolution No. 88-63). The federal government has defined potential drinking water sources in several regulations and guidance documents. Under the Federal Underground Injection Control (UIC) Program Regulations (40 CFR 146.3) groundwater containing as much as 10,000 ppm TDS may be considered an underground source of drinking water. A more detailed definition of potential sources of drinking water is given in EPA's "Guidelines for Ground Water Classification under the EPA Ground Water Protection Strategy (1986)." Under this guidance document, a potential source of drinking water must also be able to be used without treatment or must be able to be treated using methods reasonably employed in a public water system in addition to meeting the 10,000 mg/l limit for TDS.

The A-aquifer in the immediate vicinity of the JASCO Site does not represent a current or potential beneficial use as a drinking water source as defined by the State Water Resources Control Board Resolution No. 88-63 due to the levels of total dissolved solids and because the aquifer could not be utilized as a drinking water source without treatment or with methods reasonably employed in a public water system. The A-aquifer does meet Federal Criteria as a potential drinking water source.

The 3,100 mg/l TDS concentration detected at well V-3 also exceeds the 500 mg/l Secondary Maximum Containment Level as defined by the National Secondary Drinking Water Regulations (40 CFR 413.3) and the 1,000 mg/l Secondary Drinking Water Standards as set by California Department of Health Services (Title 22, CCR, Sect. 64473). Analyses for chloride, color units, manganese, odor threshold, and turbidity in the sample from this sample also exceeded Federal and state secondary drinking water standards. Fecal coliform bacteria were detected in this sample as well. Because the Site is located in an area prone to salt-water intrusion, it is likely that development of A-aquifer groundwater could result in an increase in the total dissolved solids within the aquifer.

**B-Aquifer.** As with the A-aquifer, the B-aquifer is limited as a potential drinking water source by water quality. No general chemistry analyses were conducted on B-aquifer groundwater at the site; however, data is available from the B-aquifer at several sites located within a two mile radius of JASCO. The majority of B-aquifer wells sampled at the "Mountain View 5" study area (Harding Lawson Associates, 1987) and at the Teledyne/Spectra Physics study area (Levine-Fricke, 1986) exceeded established drinking water standards for at least one major ion. Many of the samples contained detectable amounts of fecal coliform. Based on these data it is unlikely that B-aquifer groundwater could be considered a current or potential drinking water source.

**C-Aquifer.** The C-aquifer is currently used to supply a portion of the potable water provided to Bay Area users. This aquifer represents both a current and potential beneficial use as a potable water source.

#### 1.2.8 Baseline Risk Assessment

An Endangerment Assessment for JASCO site was prepared by Jacobs Engineering Group Inc., an EPA consultant, in August of 1989 (see Appendix B, Jacobs Endangerment Assessment). This report did not take into account the removal of soil with high concentrations of target constituents from Area DS-3 in 1988.

The conclusions of the Jacobs (1989) EA are that the site does not pose a significant health risk under current land-use conditions. The only current exposure route was determined to be the inhalation of volatile compounds and the potential cancer risk was determined to be less than  $10^{-6}$ . Risks associated with exposure to contaminated soil by ingestion of surface soil or inhalation of fugitive dust were not significant. Under future land-use conditions, the site could pose a significant risk via ingestion and inhalation of volatile compounds in groundwater used for domestic purposes. Jacobs (1989) estimated that a maximum plausible excess cancer risk of  $4 \times 10^{-3}$  for ingestion and  $6 \times 10^{-4}$  for vapor inhalation would be associated with use of groundwater in the A-aquifer for domestic water supply. For carcinogens, a significant risk is considered to be an increased risk of developing cancer of greater than  $1 \times 10^{-6}$  as a result of lifetime exposure. Use of groundwater for domestic purposes would also pose significant non-carcinogenic risks.

OHM has reviewed the Jacobs (1989) Endangerment Assessment and generally concurs with the conclusions of the report; however, changes in site conditions since the EA was conducted may have reduced the risks calculated by Jacobs. The EA did not take into account the removal of soil with high concentrations of target constituents in 1988 or the unsuitability of A- and B(1)-aquifer groundwater for drinking water purposes. The drainage swale excavation program conducted in 1988 has significantly reduced the quantity of soil containing target constituents. The extraction program at well V-4, which has been in operation since 1987, has reduced the number and

concentrations of target constituents in A-aquifer groundwater and limited the migration of the target constituent plume both laterally and vertically.

The EA concluded that, while there are no significant risks under current land-use conditions, future domestic use of downgradient A-aquifer groundwater could pose a health risk. This potential scenario is unlikely, however, because the A-aquifer does not appear to meet the State's criteria as a potential drinking water source. Total dissolved solids and several other constituents related to regional hydrologic conditions have been detected in groundwater from the Site at concentrations exceeding State and Federal Secondary Drinking Water Standards. Salt water intrusion is a problem throughout the South Bay area and has forced local agencies to restrict use of the A-aquifer. The Santa Clara Valley Water District Ordinance (SCVWD) No. 85-1, Section 7, allows only monitor wells to be installed in the A-aquifer. SCVWD also requires potable water wells be constructed with a minimum 50-foot sanitary seal. This would preclude the use of the A- and B(1)-aquifer groundwater as drinking water.

### 1.2.9 Applicable or Relevant and Appropriate Requirements (ARARs)

Applicable requirements have been defined as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (EPA, 1988). Relevant and appropriate requirements, while not applicable, "address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (EPA, 1988).

The determination and evaluation of potential ARARs has been an ongoing activity in the RI/FS process for the Jasco Site. Table 1.10 presents all potential ARARs for the Jasco Site as evaluated by EPA. Included in this table is a determination of whether the statute or regulation is applicable to the Site, relevant and appropriate for the Site, or both.

There are three types of ARARs. Contaminant-specific ARARs address the presence of individual constituents of groups of specific constituents in the media of concern. Most commonly these ARARs are represented as water quality standards or permissible contaminant levels. Action-specific ARARs are standards that are focused upon the types of activities being conducted. Among the most common of these ARARs are regulations setting standards for waste treatment technologies or procedures for the disposal of wastes. The third type of ARARs are location-specific. These ARARs are usually associated with the protection of historic or biologically sensitive areas through the restriction of activities in these areas. The following is a discussion of potential ARARs with a comparison of the ARAR to existing Site conditions. The discussion will be divided by the medium of concern (i.e. soil, groundwater, air). Both contaminant- and action-specific ARARs will be discussed. No location-specific ARARs have been identified for the JASCO Site.

#### 1.2.9.1 ARARs for Groundwater

Potential ARARs for groundwater at the Jasco Site include contaminant-specific ARARs related to the use of groundwater resources for potable water supplies and action-specific ARARs related to the protection of aquifer resources and water treatment systems.

Federal ARARs that have been evaluated include the National Primary and Secondary Drinking Water Standards and Maximum Contaminant Level Goals. The Primary Drinking Water Standards are enforceable Maximum Contaminant Levels for current or potential drinking water sources and are applicable to the Site. The Maximum Contaminant Level Goals are non-enforceable standards that EPA has used under CERCLA in cases where cleanup levels more stringent than MCLs are necessary. For this reason, they are relevant and appropriate but are not applicable to the Site. Maximum Contaminant Level Goals are not enforceable but may be used as guidance during the establishment of cleanup levels. Table 1.11 summarizes established standards for constituents identified in groundwater and/or soil at the Site.

Chemical-specific State ARARs included the California Safe Drinking Water Act and Water Quality Objectives as defined by the Regional Water Quality Control Board. The Safe Drinking Water Act sets Primary and Secondary Maximum Contaminant Levels for Primary Drinking Water Sources. These standards are appropriate and relevant but not applicable to the Site. Table 1.11 summarizes established standards for constituents identified in groundwater and/or soil at the Site. Two State resolutions adopted through the Porter Cologne Water Quality Control Act and administered through the Regional Water Quality Control Board are applicable to the Site. State Resolution 68-16 requires the maintenance of existing water quality unless the change would benefit the public or would not result in an unreasonable effect on current or potential uses or the ability to meet other State policies. State Resolution 88-63 sets criteria to determine whether an aquifer has a current or potential beneficial use.

Additional Federal ARARs that relate to groundwater conditions at the Site are the National Pollutant Discharge Elimination System (NPDES) and the National Pretreatment Standards. These ARARs provide standards for the administration of programs to control pollutants entering water bodies or publicly-owned treatment works and are largely action-specific. Both potential ARARs are applicable to the JASCO Site. Several potential State ARARs may also be pertinent to the Site. These include the Porter-Cologne Water Quality Control Act which provides the mechanism for the development and enforcement of State water quality standards.

Nine target constituents were detected in A-aquifer groundwater during the sampling phases conducted in 1991 at the Site. Of these constituents, four have established State and/or Federal Standards. During the most recent sampling phase in January of 1992, groundwater collected from one well location (V-4) exceeded Federal and/or State Maximum Contaminant Levels (MCLs) for 1,1-DCA, 1,1-DCE and vinyl chloride. None of the groundwater samples exceeded Federal and/or State standards for 1,1,1-TCA. None of the samples collected from other monitor wells during this phase exceeded State or Federal MCLs.

#### 1.2.9.2 ARARs for Air

Potential ARARs for air emissions at the Site are limited to the Federal Clean Air Act and National Primary and Secondary Ambient Air Standard, the State Air Resources Act and Air Toxics Hot Spots Information and Assessment Act and the Bay Area Management Pollution Control District Rules and Regulations.

The National Primary and Secondary Ambient Air Standards are contaminant-specific standards for the protection of public health and welfare. While not applicable, they are relevant and appropriate for alternatives that may result in the emission of regulated pollutants. The State ARARs relating to air emissions are administered through the Regional Air Pollution Control District. These are

action-specific ARARs applicable to Site alternatives that may result in the emission of regulation pollutants such as air stripping and vapor extraction.

#### 1.2.9.3 ARARs for Soil

EPA has set contaminant-specific standards for target constituents present in Site soils. These standards are based on the potential for target constituents to migrate into Site groundwater at concentrations exceeding drinking water standards. These standards are discussed in greater detail in Section 2.0. The State has developed criteria to define whether a material is hazardous based upon concentrations of contaminants in a waste. These concentrations are expressed as soluble threshold limit concentrations (STLC) and total threshold limit concentrations (TTLC). While these concentrations do not represent cleanup levels, they are applicable to the Site with respect to the treatment and disposal of waste material. STLCs and TTLCs have been established for only two of the target constituents at the Site. The STLC and TTLC for trichloroethylene are 204 mg/l and 2040 mg/kg, respectively and the TTLC for vinyl chloride is 10 mg/kg.

## 2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

### 2.1 INTRODUCTION

This initial screening step consists of identifying remedial technology types and selecting the most appropriate process option within each remedial technology type for detailed evaluation. Appropriate process options must satisfy the remedial objectives and be technically implementable. The remedial objectives are based upon information from the Endangerment Assessment.

After the range of appropriate process options has been identified, one option, if possible, is selected for each technology type. This selection is based upon effectiveness, implementability, and cost. More than one option may be selected if they are sufficiently different in their performance that one would not adequately represent the other, or if two options appear to meet the criteria for selection. These options are developed into remedial alternatives.

A detailed analysis of the selected alternatives is performed to evaluate each alternative against the nine criteria specified by EPA and to provide relevant information to aid decision-makers in their selection of a site remedy. These nine criteria are:

- 1) Overall protection of human health and the environment;
- 2) Compliance with ARARs;
- 3) Long-term effectiveness and permanence;
- 4) Reduction of toxicity, mobility, and/or volume of target constituents;
- 5) Short-term effectiveness;
- 6) Implementability;
- 7) Cost;
- 8) State acceptance; and
- 9) Community acceptance.

### 2.2 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives for the Site must address the contaminants of concern, the exposure routes and the potential receptors. Potential risks to human health and the environment were calculated by Jacobs Engineering Inc. (Jacobs), in the Endangerment Assessment for the Site (Appendix B). Jacobs concluded that the only significant risks posed by the Site were related to the ingestion of A-aquifer groundwater and the inhalation of groundwater vapors. No significant carcinogenic or non-carcinogenic risks were calculated for the incidental ingestion of soil or the inhalation of fugitive dust. Jacobs defined significant carcinogenic risk as one that would result in a potential excess cancer rate to a population to be one in a million ( $1 \times 10^{-6}$ ). Although no risks were calculated for exposures to soil containing target constituents, the remedial action objectives will address the presence of constituents in soil because of the potential for further degradation of groundwater quality.

Jacobs concluded that future risks could result from the use of A-aquifer groundwater as a drinking water source. Based on data collected from one on-site well in 1987, the A-aquifer does not meet the State's criteria but does meet Federal criteria as a drinking water source. A sample collected from A-aquifer well V-3 in 1987 exceeded the 3,000 mg/l limit for total dissolved solids (TDS) used by the State of California to define a potential drinking water source (State Resolution 88-63). Federal and State secondary drinking water standards for TDS, chloride, color units, manganese,

odor threshold, and turbidity were also exceeded. Based upon these data, the A-aquifer could not be used as a drinking water source without substantial treatment due to the presence of constituents unrelated to Site activities. In addition, the local regional water district restricts the use of A-and B-aquifer groundwater in order to prevent subsidence and to limit the potential for saltwater intrusion.

The B-aquifer, which underlies the A-aquifer, is also not believed to be a potable water source based upon data collected at other sites in the Mountain View area (see Section 1.2.7). Target constituents have been detected in B(1)-aquifer groundwater at the Site but current levels are below the maximum contaminant levels. The C-aquifer, encountered at a depth of approximately 150 feet in the Mountain View area, is a potable water source that provides a portion of the water supply to the Southern San Francisco Bay Area.

The remediation action objectives for the protection of human health and the environment are: 1) the restoration of A-aquifer groundwater; and 2) the vertical and lateral containment of the plume of target constituents in the A-aquifer. Central to these goals is the prevention of vertical migration of target constituents from vadose zone soil and A-aquifer groundwater to the underlying drinking water sources (C-aquifer). Obtaining these objectives will prevent the ingestion of water containing target constituents in excess of Maximum Contaminant Levels (MCLs) and will prevent a total cancer risk of greater than  $10^{-4}$  to  $10^{-6}$ . The following is a discussion of remedial action objectives as they relate to the media and constituent of concern.

### 2.2.1 Soil

OHM identified 11 key chemicals for assessing soil remedial actions goals at the Site:

Benzene	Tetrachloroethane
1,1-Dichloroethane	1,1,1-Trichloroethane
1,2-Dichloroethane	Trichloroethene
1,1-Dichloroethene	Vinyl Chloride
Methylene Chloride	Petroleum Hydrocarbons
Pentachlorophenol	

This list includes all of the key constituents identified by Jacobs in the Endangerment Assessment (1989). Pentachlorophenol (PCP) has not been identified in any of the soil samples collected after the EA had been conducted and has been detected in only two groundwater samples, the latest being in April of 1990. The concentrations at which PCP was detected in groundwater only slightly exceeded the detection limit. Vinyl Chloride has not been detected in any of the soil samples collected from the site but has been detected in A-aquifer groundwater. 1,1,1-Trichloroethane and petroleum hydrocarbons were added to the list by OHM because they have been detected at elevated concentrations in soil and groundwater samples at the Site. Of the key constituents, all are considered possibly carcinogenic with the exception of 1,1,1-Trichloroethane and Petroleum Hydrocarbons.

Jacobs (1989) modelled the migration of chemicals at the JASCO site using a one-dimensional analytical model to evaluate the downward leaching of chemicals from vadose zone soils into the A-aquifer and a numerical model (SUTRA) to model the downgradient migration of chemicals within the aquifer. Based on the modelling effort in the Endangerment Assessment, a ratio between the concentrations in downgradient groundwater was determined. The concentrations of target constituents in groundwater have decreased since the Endangerment Assessment was conducted.



PRC Environmental Management Inc. (1992) conducted additional modelling of constituent migration using Summer's leachate model (USEPA, 1989). This model was used to estimate the concentration of a constituent in soil which when leached from the soil (calculated from Site-specific hydrogeologic data) would result in a A-aquifer groundwater concentration equal to the Maximum Contaminant Level (MCL) for that constituent. Based upon these calculations, final constituent-specific soil cleanup standards were set that are protective of the exposed population assuming the A-aquifer is used for potable and domestic purposes. This report also provided a recalculation of health-based risks posed by target constituents at the Site. A copy of PRC's 1992 report is included as Appendix D. The remedial action objectives for soil at the Site are to remediate soil containing key constituents to the levels as shown in Table 2.1 as defined by PRC's 1992 report.

There are limitations to the models used by Jacobs (1989) and PRC (1992). Neither of the models consider the degradation of constituents. Both biological and chemical degradation processes will act to break down some of the compounds. Studies at Moffett Field and elsewhere have indicated that some biodegradation of halogenated organic compounds is occurring. The occasional detection of vinyl chloride, a breakdown product of trichloroethylene and dichloroethylene, at the JASCO site may indicate that some degradation is occurring. Both modelling efforts assumed the entire surface area of the former drainage swale area was contaminated whereas much of the most highly contaminated soil has been removed and the western portion of the drainage swale contains limited levels of target constituents. For this reason, the actual amount of dilution that would occur is likely to be greater than predicted by the models.

The models used by Jacobs (1989) do not consider retardation. Some of the compounds are expected to become tightly bound to these particles or to become trapped in soil micropores. Volatile organic compounds (VOC) will not move at the same rate as water, but will be slowed somewhat by adsorption to soil particles. These compounds may not be readily desorbed back into the water column. The models used by PRC (1992) do account for the properties that affect the ability of a chemical to be adsorbed to soil surfaces. This correction is made assuming the adsorbing material is the organic carbon content of the soil. Furthermore, the Jacobs (1989) modelling also assumed that the chemicals of concern were present in soils at a uniform concentration which is rarely true in the field.

In summary, several factors suggest that the modelling conducted by Jacobs and PRC overestimated health risks and that the soil remediation goals are overly protective of human health:

- The potential effect of either biological or chemical degradation are not considered in the models.
- The area of the former drainage swale containing the greatest quantity and highest concentrations of chemicals has been removed. Consequently, the majority of the potential source material has been removed.
- Because much of the source material has been removed, a greater amount of dilution may occur than is predicted by the models.

### 2.2.2 Groundwater

OHM has identified six key constituents in groundwater based upon their persistence in groundwater analyses conducted in 1991 and 1992 and evaluations of health-based risks: 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), methylene chloride, pentachlorophenol (PCP), 1,1,1-trichloroethane (1,1,1-TCA) and vinyl chloride. PCP has been detected in only two groundwater samples, both from well V-1, most recently in April of 1990. Four other constituents were detected in groundwater samples collected in 1991. The presence of acetone and chloroethane in groundwater samples has been sporadic and/or generally limited in extent or concentration (see tables 1.7 and 1.8 and Appendix B). Petroleum hydrocarbons have been identified at three locations in 1991 at concentrations generally less than 0.5 mg/l. The cumulative results of past investigations as presented in the Remedial Investigation suggest that the potential source areas have been sufficiently identified. Implementation of a remedy to remediate source areas with respect to the key constituents will also result in a corresponding decrease in commingled constituents.

The remedial action objectives for groundwater are the containment of the plume of key constituents in the A-aquifer and the restoration of A-aquifer groundwater to Maximum Contaminant Levels as specified by the State of California and the Federal Safe Drinking Water Act. Central to these goals is the prevention of key constituents from migrating vertically from the A-aquifer to underlying potable water sources (C-aquifer). Obtaining these goals will prevent the exposure to and ingestion of water containing key constituents in excess of Maximum Contaminant Levels (MCLs). The MCLs for key constituents are shown in Table 2.2 along with a comparison to maximum levels recorded prior to and after the interim remediation.

Despite the establishment of restoration of A-aquifer groundwater quality as a remedial action goal, it has not been established whether existing groundwater treatment technologies are capable of achieving this goal. In an EPA study of 13 sites at which aquifer restoration was a remedial action objective at only one site was the remedial action successful (Cartwright, 1991)(Travis and Doty, 1990). At six of these sites the remedial action objective was modified from aquifer restoration to plume containment. The absence of target constituents at B(1)-aquifer well I-1, adjacent the A-aquifer well containing the greatest concentrations of constituents, suggests that the extraction system in place at well V-4 is effective at preventing vertical migration of contaminants and that plume containment is an achievable goal.

### 2.2.3 Comparison of On-Site Concentrations with Remediation Goals

#### 2.2.3.1 Soil

Results of analyses of soil samples collected from the Site indicate that most chemicals are present at levels below the soil remediation standards goals. Table 2.1 shows a comparison between the selected cleanup standard for each target constituent and the maximum concentration detected in Site soil both including and excluding interim remedial measures. The highest concentrations of target constituents in soil were detected in former drainage swale area DS-3 (Figure 1.8) which was remediated by excavation and off-site disposal in 1988. Excluding this area, only five target constituents have been detected in Site soil at concentrations exceeding the selected soil cleanup standard: 1,1-DCA, acetone, benzene, methylene chloride, and toluene.

In drainage swale area DS-1, the selected cleanup standard of 0.2 mg/kg for methylene chloride was exceeded in 9 of 17 soil samples (53%), the selected cleanup standard for 1,1-DCA of 0.6

mg/kg was exceeded in 4 of 17 samples (24%) and the selected cleanup standard for toluene of 3 mg/kg was exceeded in 5 of 17 samples (29%). The maximum detected concentrations of methylene chloride, 1,1-DCA and toluene in these samples were 4.2 mg/kg, 3 mg/kg and 110 mg/kg, respectively. None of the samples collected from this area contained acetone or benzene or other target constituents at concentrations exceeding the selected cleanup standard. The depths at which these samples were collected ranged from 3 feet to 30 feet.

In drainage swale area DS-2, only 3 of 27 samples (11%) contained target constituents at concentrations exceeding the selected cleanup standard. Each of these samples were collected from a depth of 3 feet at the eastern portion of area DS-2. All three of the samples contained methylene chloride exceeding the cleanup standard with concentrations ranging from 0.68 to 6.2 mg/kg. Two contained acetone above the cleanup standard at concentrations of 49 and 100 mg/kg. Only one contained 1,1-DCA above the cleanup standard with a concentration of 0.61 mg/kg. No other selected cleanup standards were exceeded in any of the samples collected from this area. The three samples which exceeded selected cleanup standards were collected in 1988. The present concentration of these constituents may be less than those recorded in 1988 because the constituents in question are volatile and they were detected at a shallow depth where volatilization would be more likely. Samples collected from this area in 1990 did not exceed any of the selected cleanup standards.

In the former diesel fuel storage tank area, selected cleanup standards were exceeded for only methylene chloride and benzene. The cleanup standard for benzene was exceeded in both of the samples collected from the excavation during tank removal at concentrations of 3.0 and 0.39 mg/kg. The cleanup standard for methylene chloride of 0.2 mg/kg was exceeded at only one sample (0.25 mg/kg) collected from the depth of one foot at a location just north of the former tank area.

Methylene chloride was the only target constituent present in soil from the underground storage tank and drum storage areas at a concentration exceeding the selected cleanup standard. The soil cleanup standard was exceeded in 6 of 25 samples (24%) collected from the underground storage tank area and in 4 of 12 samples (33%) collected from the drum storage area. Methylene chloride was detected at depths ranging from one foot to 20 feet in these areas at concentrations ranging from 0.35 to 2.4 mg/kg.

#### 2.2.3.2 Groundwater

Maximum Contaminant Levels (MCLs) for three constituents (1,1-DCA, 1,1-DCE and vinyl chloride) and the proposed Maximum Contaminant Level for methylene chloride have been exceeded at the Site in groundwater samples collected in 1991 and 1992. Table 2.2 shows the selected cleanup standards for the target constituents with a comparison to concentrations recorded in January of 1992 and in the four sampling phases conducted in 1991. Appendix A shows the historic groundwater quality data for the Site. Based upon the most recent groundwater analyses in January of 1992, groundwater cleanup standards were exceeded for only three target constituents (1,1-DCA, 1,1-DCE and vinyl chloride) and at only one well location (V-4).

The concentration of 1,1-DCA at well V-1 has exceeded the MCL only three times since 1987 and most recently in July of 1990 and the concentration of 1,1-DCA at well V-3 has exceeded the MCL only once (November 1991) since December of 1989. The concentration of 1,1-DCA at wells V-4 and V-7 have consistently exceeded the MCL at well V-4. The MCL for 1,1-DCA has not been exceeded at any of the remaining A-aquifer wells at the Site.

The MCL for 1,1-DCE has been exceeded only once at well V-1 (January 1988) and only twice at well V-3 (September 1987, January 1988). The concentration of 1,1-DCE at well V-4 has consistently exceeded the MCL. The MCL for 1,1-DCE has been exceeded only once at well V-7 (January 1991) since March of 1988. The MCL for 1,1-DCE has not been exceeded at any of the the remaining A-aquifer wells.

The proposed MCL for methylene chloride has been exceeded in approximately half of the samples collected from well V-1. In 1991, the proposed MCL was exceeded in two of the four samples collected from this well but the maximum concentration was 0.0058 mg/l or only slightly greater than the proposed MCL of 0.005 mg/l. At well V-3, the proposed MCL for methylene chloride has not been exceeded since July of 1990 and has been exceeded in less than half of the samples collected since 1986. The proposed MCL for methylene chloride was exceeded at well V-4 during the previous two quarterly sampling phases but prior to this had not been exceeded since January of 1990. The proposed MCL for methylene chloride at well V-4 has been exceeded in approximately half of the samples collected since 1987. The only other A-aquifer well at which the proposed MCL for methylene chloride was exceeded was well V-10 and then only during one sampling phase (January 1989).

The MCL for vinyl chloride was exceeded only once in 1991 at well V-4 during the April sampling phase. Vinyl chloride has been detected in less than half of the groundwater samples collected at well V-4 since the initiation of groundwater monitoring (see tables 1.7 and 1.8). Vinyl chloride has not been detected in groundwater collected from wells V-3 and V-7 since January of 1988. Vinyl chloride has not been detected at any other of the remaining A-aquifer wells. The MCL for 1,1,1-TCA has not been exceeded at any well location since December of 1989.

## 2.3 GENERAL RESPONSE ACTIONS

To achieve the remedial action objectives required for JASCO, general response actions or conceptual remediation measures were developed in accordance with EPA guidelines for performance of feasibility studies under CERCLA. General response actions which may be pertinent for remediation of the groundwater and soil are presented in Table 2.3, General Response Actions for Groundwater and Soil.

## 2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

### 2.4.1 Initial Screening and Elimination of Technologies

Remedial technologies within each response action and process options associated with a given technology have been identified and evaluated. The remedial technologies and process options were initially evaluated for technical implementability. A process option may be considered not implementable if it cannot adequately treat the target constituents present or if it would be difficult to construct and maintain the process operation on-site. Those technologies or process options which cannot effectively be implemented have been eliminated from further consideration. The technologies and options which were evaluated are listed in Table 2.4 for groundwater and in Table 2.5 for soil.

#### 2.4.1.1 Groundwater Remediation Options Eliminated from Evaluation

The following groundwater remediation options were eliminated from further consideration:

- Horizontal Barriers
- Alternate water supply
- Coagulation/Flocculation
- Filtration
- Reverse Osmosis
- Dechlorination
- Neutralization
- Solvent Extraction
- Injection wells.

**Horizontal barriers** are used to prevent the vertical migration of target constituents. The flow of leachate passing through soil containing target constituents is impeded by the installation of a horizontal barrier. A horizontal barrier does not prevent lateral migration nor does it reduce the concentration of target constituents. A horizontal barrier would not be effective at JASCO since the target constituents have already migrated to groundwater.

**Alternative water sources** are not applicable since the local population does not use the A-aquifer or B(1)-aquifer groundwater.

**Coagulation/flocculation** is a physical/chemical process in which fine particulate matter is conditioned for removal from a waste stream by addition of inorganic or organic chemicals. These induce and accelerate the aggregation of the particulates into larger, settleable particles. This is not applicable for JASCO since there are no suspended constituents.

**Filtration** is a physical process which separates particles suspended in a fluid by forcing the fluid through a porous medium. As the fluid passes through the medium, the suspended particles are trapped on the surface of the filter medium and/or within the voids of the medium. This is not applicable for JASCO since there are no suspended constituents.

**Reverse osmosis** is a membrane separation process which uses mechanical force (high pressure from 250 to 1500 psi) as the primary driving force for transport of solute (usually water) through a membrane, concentrating the dissolved components. Water passes through the membrane, while the dissolved matter is left behind. This is essentially a molecular sieve, separating water from dissolved matter. The ratio between the clean water passing through the membrane and the rejected dissolved matter depends on the initial concentration of dissolved matter in the waste stream. The higher the concentration, the higher the rejected fraction. The level of the initial concentration will also determine the type of membrane to be used. Periodic washing of the membrane is required. Reverse osmosis cannot be effectively implemented at JASCO because it is designed for chemical compounds with molecular weights greater than 100 grams per mole and the majority of the constituents present at JASCO do not meet this criteria.

**Chemical dechlorination** refers to a group of technologies which can be used to strip chlorine atoms from specific highly-chlorinated toxic compounds, such as PCBs and dioxins. Several commercial processes for treatment of transformer fluids are sodium-based, using proprietary solvents. Other processes which use a potassium compound in combination with other alkali

metals in polyethylene glycol are in development. Dechlorination processes strip the chlorine from the organics to form an alkali metal salt and a substituted organic polymer. The majority of constituents at JASCO are not highly-chlorinated and could not be successfully treated by these processes.

**Neutralization** is a chemical process consisting of adding an acid or an alkali to a waste stream in order to adjust its pH. Neutralization is not applicable since there is no pH problem.

**Solvent extraction** is a process in which selected constituents of a liquid solution are extracted by contacting it with another immiscible liquid, usually a solvent. The constituents to be removed must be more soluble in the extracting solvent than in the original solution. Solvent extraction would be difficult to implement at the Site because of the low concentration of constituents present in the groundwater. If the extracting solvent dissolves, even dilutely, in the groundwater, this process may actually increase the volume of contaminants in Site groundwater. It is also difficult to find a solvent which will satisfactorily extract all the constituents from water. As a result, a series of solvents would most likely be required, which would not be technically- or cost-effective.

**Injection wells** could be used to reinject treated groundwater back into the aquifer. Under favorable conditions, the reinjected water may act to flush contaminants from the soil and accelerate soil and groundwater remediation. The potential use of injection wells at the Site was eliminated because: 1) existing technologies may not be able to treat the extracted groundwater to acceptable levels prior to injection; 2) the limited extent of target constituents in soil would make it difficult to locate injection wells where they could aid in the flushing of contaminants in soil; 3) the placement of injection wells near the former drainage swale area would jeopardize the ability of the extraction system to prevent downgradient migration of groundwater containing target constituents; and 4) the costs involved in the installation of injection wells and acquiring a Waste Discharge/NPDES Permit through the Regional Water Quality Control Board may outweigh any savings gained through improved remedial action effectiveness.

#### 2.4.1.2 Soil Remediation Options Eliminated from Evaluation

The following soil remediation options were eliminated from further consideration:

- Dechlorination
- Neutralization
- Carbon Adsorption
- Resin Adsorption
- On-site Incineration.

**Dechlorination** and **neutralization** process options are not appropriate for the same reasons stated for the remediation of groundwater.

**Carbon adsorption** and **resin adsorption** cannot be applied directly to the soil. The target constituents must first be transferred to an aqueous or gaseous stream to use these processes. If either mass transfer processes can be successfully accomplished these options may be reconsidered. The transfer process would first require either soil washing or vapor extraction.

**On-site incineration** is the destruction of target constituents by exposing them to extremely high temperatures (in excess of 1000 °C). It is an effective process but would be impractical to implement because of the proximity to local housing and the concerns regarding community

acceptance. This method would not be cost effective for the small amount of soil present at this site because the cost of an on-site incinerator for a small site is prohibitive.

#### 2.4.2 Selection of Representative Process Options

The remaining process options were evaluated for their effectiveness, implementability, and cost. One process, if possible, has been chosen to represent each technology. Table 2.6 and Table 2.7 present a summary of the evaluation for groundwater and soil, respectively.

##### 2.4.2.1 Applicable Remedial Process Options for Groundwater

For groundwater, the applicable process options selected for each technology are as follows:

<u>Remedial Technology</u>	<u>Process Option</u>
No Action	None
Access Restrictions	Deed Restrictions
Monitoring	Groundwater Monitoring
Extraction	Groundwater Extraction
Off-site Discharge	Publicly-Owned Treatment Works (POTW) Discharge
On-site Treatment:	
Biological Treatment	Anaerobic/Aerobic
Physical Treatment	Carbon Adsorption
Physical Treatment	Air Stripping
Chemical Treatment	Ultraviolet Peroxidation
In Situ Treatment:	
Biological Treatment	Anaerobic/Aerobic

#### No Action

The No Action option must be retained per the National Contingency Plan. No action would consist of shutting down the groundwater extraction and discharge, discontinuing the quarterly monitoring of monitor wells, and allowing the plume of target constituents to degrade naturally. Further migration of the plume would most likely occur. Local, state, and federal agencies do not consider this an acceptable option.

#### Deed Restrictions

Deed restrictions would limit the future use of groundwater at the site. Even without the deed restrictions, it is unlikely the groundwater in the A-aquifer will ever be used for potable water. The Santa Clara Valley Water District Ordinance (SCVWD) No. 85-1, Section 7, prohibits water supply wells to be installed in the A-aquifer, allowing only monitor wells. SCVWD also requires potable water wells be constructed with a minimum 50-foot sanitary seal. This would preclude the use of the A- and B(1) aquifer groundwater as drinking water.

### Groundwater Monitoring

Groundwater monitoring includes groundwater level measurement, the collection of groundwater samples and analysis of the samples for a range of target constituents. Quarterly groundwater monitoring is currently conducted to characterize and monitor the quality of groundwater at JASCO.

### Groundwater Extraction

Groundwater extraction from the sub-surface reduces the amount of target constituents present within the aquifer and limits the extent of vertical and lateral migration by capturing groundwater. Groundwater extraction from the A-aquifer has been in operation since 1987. Once extracted, the water is discharged to the City of Mountain View's sewage treatment plant. If maximum sustainable pumping rates in the A-aquifer decrease, additional extraction wells may need to be installed to adequately capture groundwater flowing past the former drainage swale area and to treat the groundwater on a larger scale (see Appendix D, Groundwater Extraction System). Groundwater capture through the installation of additional wells would require that the aquifer yield is adequate and wells could be placed in feasible locations. A minimum of one extraction well and a maximum of three wells (at the minimum anticipated pumping rate of 0.5 gpm) would be required to capture A-aquifer groundwater in the direction of flow across the former drainage swale area. The basis for the extraction system is presented in Appendix D.

### Off-site Discharge: Publicly Owned Treatment Works (POTW)

JASCO has been discharging extracted groundwater to the City of Mountain View's sewage treatment facility since 1987. The water is treated at the Publicly Owned Treatment Works (POTW). This discharge is permitted by the City of Mountain View. The discharge is monitored monthly to ensure the concentrations do not exceed the levels set by the permit, which are less than 1 ppm total organics and less than 0.75 ppm for any one constituent as analyzed by EPA Method 601/602. In addition to treating groundwater this remedial technology also provides for the containment of the target constituent plume through the extraction of groundwater.

### Ex Situ and In Situ Biological Treatment

Biological treatment relies on natural or specialized bacteria to remove organic constituents from wastewater or soil. Provided the organic material is not toxic or refractory, and its concentration is not prohibitive to bacterial activity, bacteria can utilize the organic constituents as food. Certain biochemical reactions proceed in an aerobic environment (i.e., dissolved oxygen is present in the waste stream), others in an anaerobic environment (i.e., the waste stream is devoid of dissolved oxygen). Regardless of the treatment environment, the process involves two pathways. In one pathway, bacteria synthesize organic matter for their metabolism and propagation of the species. In the second pathway, bacteria oxidize organic matter to the end product: carbon dioxide and water in the case of aerobic treatment, carbon dioxide and methane in anaerobic systems. In doing so, they produce the energy they need to sustain metabolism.

Currently there are no commercially-demonstrated biological processes in use which will totally degrade TCA, TCE, PCE, and vinyl chloride, although there is considerable progress being made in laboratory and pilot-scale studies. Most of the other organic non-chlorinated constituents are known to be biodegradable. The bioremediation processes which exist degrade the above chlorinated components to DCA or DCE and then finally to vinyl chloride which may then be



removed in a vapor phase. There are experimental processes which are being tested that may degrade these compounds further. These experimental processes utilize both aerobic and anaerobic treatment. JASCO may consider evaluating these processes at its site and, for this reason, both aerobic and anaerobic biotreatment have been retained for on-site technology consideration.

The ex situ bioremediation remedial technology is being retained. Biological treatment can be performed either aerobically or anaerobically. Although recent research performed at Stanford University suggests that in situ bioremediation may be possible, soil conditions at the Site would hinder the use of this technology. Based on this information, the in situ option has not been retained for further evaluation.

### Carbon Adsorption

Adsorption processes rely upon surface phenomenon and molecular diffusion. The surface phenomenon remove dissolved organics from aqueous waste, or organics from air streams, through surface attachment to granular material of suitable characteristics. The organics are also removed from the waste stream as the molecules diffuse into the pore spaces of the carbon. Adsorption takes place when organic molecules in the liquid (or gaseous) phase become attached to the surface of the granular material, as a result of the attractive forces at the granular surface (adsorbent) overcoming the kinetic energy of the liquid (or gaseous) constituents (adsorbate) molecules.

Activated carbon, a porous material having a large surface area per unit volume and a non-polar surface, can adsorb most organic compounds to some degree, although carbon usage can be excessive for certain constituents (e.g., vinyl chloride). Greater than 99 per cent removal efficiency can be achieved for many organics. Exhausted carbon (i.e., carbon saturated with organics) is usually regenerated by thermal processes by the vendor off-site.

### Air Stripping

Stripping is a mass transfer process in which volatile constituents are transferred from an aqueous solution into the gaseous phase. The stripping medium can be air or steam.

Air stripping is a proven technology for the removal of volatile organics from water; the non-volatiles remain in the stripped groundwater. It is accomplished normally in a counterflow packed tower, with the aqueous solution flowing downward and the air blown upwards. It is sometimes accomplished in an aerated tank where air is bubbled through the water.

Carbon adsorption, or another capture or destruction technology, must be provided in conjunction with stripping. This is due to the Bay Area Air Quality Management District's (BAAQMD) emission control standards.

### Ultra Violet (UV) Oxidation

UV oxidation is a catalyzed oxidation process used to destroy organic compounds. Chemical oxidation of hydrocarbons produces carbon dioxide and water. Oxidation of halogenated hydrocarbons produces inorganic halides. In the process, an oxidant, usually hydrogen peroxide or ozone, is added to the wastestream. After the addition of the oxidant, the wastestream flows across UV lamps. The energy from the UV light catalyzes the chemical oxidation of the organic compounds. Many organic compounds absorb energy from UV light and may undergo a change

in their chemical structure or become more reactive with chemical oxidants. This increase in reactivity enhances the oxidation process. This is an effective process for destroying many organic compounds, including chlorinated organics.

#### 2.4.2.2 Non-Applicable Remedial Process Options for Groundwater

Several groundwater remedial process options were deemed to be non-applicable for the target constituents at JASCO. A description of these processes and their faults are discussed further.

##### Cap

A cap above soil containing target constituents would prevent surface water from leaching down through the soil resulting in vertical migration of target constituents. A cap could be considered as an interim action until remediation begins at the site but it would not resolve the long-term potential for environmental degradation. At present a soil runoff collection system is maintained in the former drainage swale area as an interim action. The cap consists of several layers of an impermeable membrane and overlying soil graded to direct runoff to a collected sump where it is pumped to the municipal sewer system.

##### Vertical Barriers

This technology involves the construction of an impermeable vertical barrier to stop the lateral migration of target constituents. The barrier may be a slurry wall or a grout curtain.

A slurry wall is constructed by digging a trench to the depth of a confining layer and pouring a bentonite slurry mixture into the trench as it is being dug. The slurry mixture is added to prevent the trench from collapsing on itself and to prevent the intrusion of groundwater. Eventually the slurry mixture is replaced with a concrete mix which hardens in place.

A grout curtain is constructed by injecting grout under pressure into pre-drilled boreholes. The grout flows through the soil and eventually hardens. The soil must be coarse so that the grout can penetrate through it.

These barriers have limited effectiveness, are difficult to implement and are very expensive. The barriers are susceptible to cracking or erosion by corrosive leachate. A barrier constructed at JASCO would have to extend to 57 feet below the ground surface (depth to confining layer). The cost of slurry wall is \$3 to \$5 per square foot (depth by length). Grout curtains are up to 10 times as expensive. Barriers to isolate JASCO could range from hundreds of thousands to millions of dollars. The equipment necessary to implement these barriers is quite large and the presence of the railroad tracks could inhibit the placement of isolation barriers. It would very difficult to mobilize and stage this equipment in the limited space at JASCO and would not actively reduce the concentrations of target constituents.

##### Resin Adsorption

Resin adsorption operates in the same manner carbon adsorption does. The difference is that resin adsorption uses synthetic adsorbents (resins). These resins are produced using high surface, porous polymers to suit specific applications. However, the commercial availability of specialty resins for adsorption of adsorbates of different chemical characteristics is quite limited. These

resins are also more expensive than carbon. Since carbon is known to effectively adsorb most organics, it is currently the preferred method for treating water streams containing mixed organics.

### Steam Stripping

Steam stripping can be applied for organics of low to high volatility and/or of high concentration (1 to 20 per cent). This process is accomplished in a counterflow tower. The process creates a small stream of condensed steam and organics which require further treatment, usually by incineration. Steam stripping is more expensive than air stripping because it requires more energy than air stripping. This stripping method should not be necessary since the volatilities of the constituents at JASCO are high enough that air stripping will suffice in stripping them.

### Supercritical Oxidation

This is a process in which an aqueous waste stream is subjected to temperatures and pressures above the critical point of water (375 °C and 22 MPa) to oxidize organics. Under these conditions, oxygen is miscible with supercritical water and inorganics are practically insoluble. This allows the organics to be oxidized rapidly and the inorganics to be separated easily.

The process operates by feeding a pressurized waste solution into a reactor, along with air or oxygen. The combined fluid is elevated above the critical point, which causes rapid oxidation of the organics to CO<sub>2</sub>, N<sub>2</sub>, and CO. Halogens, phosphorous and sulfur are converted to weak acids. Inorganic salts are removed as a concentrated brine.

The cost to construct a facility for this process is extremely high. It is also not practical or implementable to build a long-term high-temperature, high-pressure process in a residential neighborhood.

### On-site Discharge: National Pollution Discharge Elimination System Permit

On-site discharge is defined as direct discharge to the storm sewer system or reinjection of treated groundwater. On-site discharge does not include discharges to the Publicly Owned Treatment Works (POTW) which are defined as off-site discharges. On-site discharge methods would require a NPDES permit. This permit would be obtained through the California Regional Water Quality Control Board. The permit would also require the monitoring of discharge to ensure that concentrations do not exceed allowable levels.

### 2.4.2.3 Applicable Remedial Process Options for Soil

For soil, the applicable process options selected for each technology are as follows:

<u>Remedial Technology</u>	<u>Process Option</u>
No Action	None
Access Restrictions	Deed Restrictions
Monitoring	Vadose Monitoring
Extraction	Vapor Extraction
Excavation	Excavation of areas known to contain target constituents
On-site Treatment:	
Biological Treatment	Enhanced Aerobic Treatment and X-19
Biological Treatment	Anaerobic Treatment
Soil Washing	Excalibur Treatment
In Situ Treatment:	
Biological Treatment	Aerobic/Anaerobic
Off-site Discharge	RCRA Facility

#### No Action

The No Action option must be retained per the National Contingency Plan. No action would consist of leaving all soils in place without the use of any means to prevent migration of target constituents.

#### Deed Restrictions

Deed restrictions would limit the use of the land. The land will most likely become residential property. Strict restrictions may be implemented to limit exposure to soil containing target constituents if the soil is left on-site. Examples of such restrictions include prohibiting exposed soil and requiring a concreted or landscaped cover. Some restriction already exist at the Site. The former drainage swale area, where much of the target constituents in soil is located, is within the Southern Pacific (SP) railroad right-of-way, on which residential properties would not be allowed.

#### Soil Monitoring

Soil samples will be collected and analyzed during excavation to characterize the extent of target constituents. When used in conjunction with a treatment process, sampling and analysis will also provide data regarding the progress of the treatment.

#### Vapor Extraction

Vapor extraction uses the same principle as air stripping. It is a mass transfer process in which volatile constituents are transferred from the soil to a gaseous phase. The stripping medium, air, is drawn through the soil to volatilize the constituents and transfer them to the gaseous stream. This

process can be performed in situ or ex situ. If done in situ, vapor recovery wells are constructed and air is drawn through the wells. The decision to perform in situ or ex situ vapor extraction is based in part on the type and volume of soil encountered. If the soil is air-permeable (e.g. coarse sand), in situ vapor extraction is feasible. If the soil is not very air-permeable (e.g. clay) and a nominal volume of soil is involved, ex situ treatment is more effective.

Vapor extraction has been retained, but is not expected to be effective as an in situ process due to the clay and silt content of the soil at the Site. However, vapor extraction (in combination with bioremediation) could be very effective if the soil is mixed with a bulking agent and treated ex situ, as is the case for the Enhanced Biological Treatment option.

### Excavation

Soil known to have significant concentrations of target constituents are excavated and either treated on-site or taken to a TSD facility. Soil analysis is used to confirm that the appropriate soil is removed. The soil is treated or disposed of following excavation.

### Ex Situ and In Situ Biological Treatment

As with the groundwater, both aerobic and anaerobic options are retained for ex situ and in situ biological approaches so that emerging processes can be evaluated.

Enhanced bioremediation is used for soil which contains a combination of volatile and non-volatile hydrocarbons that are biodegradable. This system is totally enclosed to assure that no air emissions occur during operation and to maintain a controlled environment for bioremediation. OHM uses an enclosed treatment system that includes a treatment vessel, air distribution system, and a vapor recovery system. The moist air passing through the soil in the vessel provides oxygen to the bacteria while simultaneously stripping the more volatile organics. The stripped air then passes through two carbon adsorption canisters that are in series. The air is monitored between and after the carbon canisters to determine when the carbon is exhausted and needs to be changed. Prior to treatment in the vessel, nutrients are added to the soil and it is pre-treated to assure adequate air distribution and biodegradation. Additional water and nutrients are added, as needed, during operation.

Another potential biological treatment method worth evaluating is a soil composting process using X-19, a proprietary soil additive that incorporates a specially-developed microbial consortium. X-19 is applied to the soil in combination with a bulking agent and the additives are thoroughly mixed into the soil. The developer of this technology claims that it is effective in biodegrading chlorinated hydrocarbons, such as TCE and TCA, to non-detectable levels. The vendor suggests that the X-19 be mixed into the target constituent containing soil along with the appropriate nutrients and water and that the entire soil pile be covered. Within several months, all of the organics supposedly will have been biodegraded and a rich soil amendment will result. Since this has not been effectively demonstrated (according to EPA protocol) for chlorinated hydrocarbons, a treatability (and possibly a pilot study) would have to be performed to properly evaluate X-19's effectiveness and overall feasibility for treating this mixed organic-containing soil.

### Excalibur Soil Washing/Catalytic Ozone Oxidation Process

The Excalibur process has been included because its inventors claim, and initial studies indicate, that it can very effectively remove mixed organic constituents from soil and destroy them using a

specialized UV oxidation process. This patented process is being demonstrated through the SITE program. It is designed to treat soils that contain organic and inorganic constituents. The technology is a two-stage process; the first stage separates the target constituents from the soil; the second stage destroys the extracted constituents. The initial extraction step uses ultrapure water (prepared on-site by a patented process) and ultrasound to separate constituents from the soil. The second step uses ozone, ultraviolet (UV) light, and ultrasound simultaneously to oxidize the constituents. The treatment byproducts are decontaminated soil and salts. This technology is being demonstrated, under the EPA's SITE program, at a PCP-contaminated wood preserving facility. This technology has not been extensively demonstrated although initial treatability results have been very encouraging. Treatability studies would be required before this process could be seriously recommended for application at JASCO.

#### RCRA-Permitted Facility

Soil is excavated and transported off-site to a RCRA-permitted facility for treatment and disposal. Off-site disposal alone is not an option because the land-ban restrictions include some of the constituents present at JASCO. The soil would need to be pre-treated (e.g., incinerated) at a RCRA facility prior to disposal.

#### 2.4.2.4 Non-Applicable Remedial Process Options for Soil

Several soil remedial process options were deemed to be non-applicable for the target constituents at JASCO. A description of these processes and their faults are discussed further.

#### Cap

A cap would prevent surface migration of target constituent by isolating soil containing target constituents from surface runoff. It would also prevent surface water from percolating down through these soil and further transporting target constituents into the groundwater. A cap could be considered as an interim action until remediation begins at the Site but it would not resolve the long-term potential for environmental degradation. At present a soil runoff collection system is maintained in the former drainage swale area as an interim action. The cap consists of several layers of an impermeable membrane and overlying soil graded to direct runoff to a collected sump where it is pumped to the municipal sewer system under permit.

#### Clay or Synthetic Liner

Soil placed within a clay or synthetic (e.g. polymer plastic) liner is isolated from groundwater. This prevents both vertical and lateral migration of target constituents into the groundwater. The liner must be adequately engineered to ensure long-term integrity. This process would not actively reduce the number and concentrations of target constituents in soil at the Site. In addition, the presence of constituent-laden soil and the space requirements of the liner would likely present unacceptable restrictions to future land use at the Site.

#### Desorption

Heat is applied to soil to vaporize the target constituents. The vapor can either be discharged to the atmosphere or collected for further treatment. This process has been eliminated from further consideration because of the high energy requirements for a relatively small volume of soil and because it is not practical or publicly acceptable to operate a volatilizer in a residential community.

Thermal treatment processes are comparatively more expensive than ex situ vapor extraction or enhanced bioremediation, which would be equally effective.

#### Heated Stripping

Heated stripping is a stripping process in which the stripping medium is heated. The medium can be steam or heated air. This process has been eliminated for the same reasons as the elimination of desorption. The energy and cost requirements would be high in comparison to other options.

#### In Situ Vitrification

In situ vitrification is a process in which the soil is heated to its melting point. The target constituents within the soil are either volatilized or thermally destroyed. Residual constituents are trapped within the matrix of the soil after it has cooled and hardened. The voids within the soil disappear and the soil experiences a loss of volume.

The technology heats the soil by means of electrodes placed around the area to be treated. A hood is placed over the area to capture off-gases. These off-gases are collected and treated.

Vitrification does not appear to be implementable at JASCO. This is an expensive technology designed for larger sites where no other option is feasible. It is most appropriate for inorganic waste and mixed waste as organics vaporize out of the soil. The area to be treated is located near the Southern Pacific Railroad tracks. The melt would extend to the tracks and any volume loss of the soil would damage the structural integrity of the tracks. The vent hood, which is 50 feet by 50 feet, could not be extended over the active tracks.

The remaining options will now be organized into remedial alternatives that are evaluated in detail in Section 3.0.

### 3.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives have been developed by combining the remaining remedial process options. These alternatives have been evaluated against the nine criteria specified by the EPA. This evaluation is summarized in Table 3.1 for groundwater alternatives and Table 3.2 for soil alternatives. These nine criteria are:

- 1) Overall Protection of Human Health and Environment;
- 2) Compliance with ARARs;
- 3) Long-term Effectiveness and Permanence;
- 4) Reductions in Toxicity, Mobility, and Volume through Treatment;
- 5) Short-term Effectiveness;
- 6) Implementability;
- 7) Cost;
- 8) State Acceptance; and
- 9) Community Acceptance.

Table 3.3 and Table 3.4 provides additional information regarding each groundwater and soil alternatives' compliance with ARARs, respectively.

The cost for the alternatives were based on vendor quotes and published information. Vendor quotes and cost calculations are provided in Appendix E. These costs are believed to be within a range of +50% to -30%. The costs are compared independent of the other criteria in Table 3.5, Present Worth Costs of Remedial Alternatives.

#### 3.1 GROUNDWATER REMEDIAL ALTERNATIVES

The groundwater remedial alternatives have been developed and are given below. Each of these alternatives incorporates a series of remedial technologies which, in combination, address the above nine criteria.

##### Groundwater Remedial Alternative I: No Action

- No Action

##### Groundwater Remedial Alternative II: Discharge to POTW

- Deed Restrictions
- Extraction, equalization and mixing
- Off-site Discharge under POTW Permit
- Regular Groundwater and Discharge Monitoring

##### Groundwater Remedial Alternative III: UV Oxidation

- Deed Restrictions
- Extraction
- UV Oxidation
- Polishing Treatment (optional)
- Regular Groundwater and Discharge Monitoring
- Off-site Discharge under POTW Permit



#### Groundwater Remedial Alternative IV: Carbon Adsorption

- Deed Restrictions
- Extraction
- Carbon Adsorption (liquid phase)
- Regular Groundwater and Discharge Monitoring
- Off-site Discharge under POTW Permit

#### Groundwater Remedial Alternative V: Air Stripping

- Deed Restrictions
- Extraction
- Air Stripping
- Regular Groundwater and Discharge Monitoring
- Off-site Discharge under POTW Permit

#### Groundwater Remedial Alternative VI: Biological Treatment followed by Carbon Adsorption

- Deed Restrictions
- Extraction
- Ex-situ Biological Treatment
- Carbon Adsorption (liquid phase)
- Off-site Discharge under POTW Permit
- Regular Groundwater Monitoring

The scoping and costing of Alternatives II through VI are based on a system consisting of three extraction wells, which is an approximation of the maximum number of wells that may be required to achieve remedial action goals. The three-well system is used here as a method for comparing groundwater remedial alternatives and does not necessarily represent the system configuration that would be utilized. The minimum extraction system will consist of one well located near the center of the present target constituent plume. The extraction system should be designed and maintained to reflect site hydrogeology at the time of extraction. Maximum sustainable pumping rates at the site have fluctuated significantly in response to changes in precipitation and recharge rates.

The scope of the system described in the FS is based in part on historic data from existing extraction well V-4 and on a model for determining the effective radius of single and multiple extraction well systems. The application of this model to site conditions is discussed in Appendix D. At the lowest recorded pumping rate of 0.5 gallons per minute (gpm), three wells located in the drainage swale area would be effective at containing and extracting the target constituent plume. At the highest recorded pumping rate of 2.2 gpm, pumping from only the existing extraction well V-4 would be more than sufficient for the same purpose. As of March of 1992, well V-4 has been extracting groundwater consistently at a rate of approximately 1.0 gpm over the preceding months. At this pumping rate, extraction well V-4 would be sufficient for containing and extracting the present target constituent plume.

The effectiveness of groundwater extraction and treatment technology is highly dependent upon site hydrogeology. Present and historic site data will be evaluated during the remedial design stage to determine the most appropriate design. Variables include the number of wells, their placement, and the distances between wells. Too few extraction wells or multiple wells placed too far apart may not contain the entire plume or may result in the splitting of the plume into smaller plumes which are more difficult to recover. Too many extraction wells may result in the recovery of a large volume of uncontaminated groundwater from outside of the plume. This previously

uncontaminated groundwater becomes contaminated by its contact with the plume and takes up available capacity in the treatment process. Extraction wells placed too close will cause interference between the radii of influence and may result in a decrease in the pumping efficiency.

The cost of installing an extraction well and tying it into an extraction system is estimated at \$10,000. The estimated cost of installing the three-well maximum system would be \$30,000 although the cost would be only \$20,000 if present extraction well V-4 could be incorporated into this system. There would be no installation costs for a one-well extraction system which utilizes existing extraction well V-4. For the sake of cost comparison, each groundwater extraction alternative will be based on a three-well system which does not utilize well V-4. The maximum flowrate from this system would be 6 gpm and the minimum would be 1.5 gpm. All treatment process equipment is based on the maximum flowrate of six gpm. The volume of groundwater that would be discharged annually from this extraction system would range from 790,000 gallons to 3,160,000 gallons.

Due to the drought conditions, it may not be possible to effectively pump the A-aquifer until the water table rises. The effective pumping rate has fluctuated from 2.2 gpm to 0.5 gpm. If minimal groundwater pumping cannot be achieved, it will likely be necessary to defer groundwater extraction until the groundwater table rises. In addition, the treatment efficiency and cost of certain systems may be impacted by the reduced flowrates.

Discharge of treated or untreated (depending on the remedial alternative) groundwater will be to the POTW under JASCO's current permit. This permit allows JASCO to discharge water which contain less than 0.75 ppm or any one organic compound and less than 1 ppm total organics. These discharge limitations will be the basis of treatment equipment. The cost for discharging under the current POTW is \$1.25 per 100 cubic feet of discharge, or \$5,500 annually, based on a discharge rate of 6 gpm. The analytical requirement for POTW discharge is a monthly EPA Method 601/602 performed on the effluent. Analytical requirements may change per the POTW. The approximate annual analytical cost would be \$1,500. The total annual cost for discharge to POTW would be \$7,000.

Most of the alternatives provide for treatment of extracted groundwater that contains target constituents above acceptable standards. The treatments recommended have the ability to treat the extracted groundwater to below the groundwater ARARs. This does not mean the concentration of target constituents in the groundwater which remains in the aquifer will decrease correspondingly. A remediation life of 10 years has been suggested as the basis for this FS, however, there is no guarantee that this will achieve the ARARs in the aquifer. Recent theory, based on long term groundwater remediations, suggest that it may be impossible, and impractical, to meet such low cleanup criteria in groundwater aquifers (Cartwright, 1991)(Travis and Doty, 1990).

### 3.1.1 Alternative I: No Action

The "no action" alternative is required for consideration by the EPA. It would require that the current extraction and discharge operations be discontinued and no other remedial action be taken.

**Overall Protection of Human Health and Environment.** According to the Jacobs Endangerment Assessment, under current land use, implementation of this alternative would not endanger public health since the groundwater is not used for any purpose. Future risk exist if the

groundwater is used for drinking water; an unlikely scenario, considering the quality of the groundwater.

**Compliance with ARARs.** This alternative could eventually comply with the ARARs through naturally occurring processes such as biodegradation, diffusion, and abiotic degradation. The time required to accomplish this is not known but would likely be a number of decades.

**Long-term Effectiveness and Permanence.** The natural degradation of the target constituents which would occur over the decades would be permanent. However, until degradation of the target constituents is complete, the target constituents could diffuse.

**Reductions in Toxicity, Mobility, and Volume.** The "no action" alternative would not reduce the toxicity or mobility of the target constituents in the short term. The volume of material containing target constituents would increase because of diffusion of the constituents.

**Short-term Effectiveness.** "No action" would not be effective in the short-term. The natural degradation of the constituents is a very long-term process.

**Implementability.** This alternative would be easily implemented. Very little would have to be done to discontinue the current extraction and discharge process.

**Cost.** There would be no cost to implement this alternative.

**State and Community Acceptance.** It is very unlikely that the State or community would accept this alternative.

### 3.1.2 Alternative II: Discharge to POTW

Groundwater would continue to be extracted and discharged to the City of Mountain View's sewage treatment plant. There would be no treatment prior to discharge. A permit from Mountain View is necessary to perform this alternative and has already been obtained. At present, this system is discharging approximately 525,000 gallons of groundwater to the POTW annually. Depending on Site hydrogeology and the number of extraction wells installed, this alternative would result in the treatment of between 790,000 gallons and 3,160,000 gallons annually.

This alternative is currently being implemented under permit. The existing permit allows JASCO to discharge groundwater containing less than 1 ppm total organic compounds and less than 0.75 ppm of any one compound as detected by EPA Method 601 and 602. Analytical requirements may change per the POTW. If there are any plumes of target constituents, this current treatment scheme would capture them.

The groundwater monitor wells and the discharge would continue to be sampled and analyzed. The monitor wells would be sampled on a quarterly basis to monitor the effectiveness of the extraction system to control the migration of target constituents.

The discharge would be sampled on a monthly basis to verify compliance with the POTW permit. Should concentrations in the discharge exceed permit requirements, the extraction would cease. The discharge would be re-sampled as needed until the concentrations were within the requirements of the permit. Once the concentrations were within the limits of the permit, extraction

and discharge would be restarted. Historically, permit conditions for extraction system discharge have been exceeded, however, they have not been exceeded since March of 1991.

**Overall Protection of Human Health and Environment.** As long as JASCO complies with the permit limit on organic compounds, the POTW will be able to adequately treat the water to a safe level. The target constituents would be removed permanently over the long-term. Migration of constituents would be controlled to prevent degradation of potential drinking water sources. The toxicity, mobility, and volume of the target constituents would be reduced. The operation of the system would not pose a threat to human health or the environment.

**Compliance with ARARs.** Under this alternative, groundwater containing target constituents above MCLs would be extracted. The extraction process would also prevent migration of target constituents.

The POTW which treats JASCO's wastewater is located in Palo Alto and discharges to the San Francisco Bay under a NPDES permit. The treated water released as effluent from the POTW does not contain detectable concentrations of constituents which are present in groundwater at the Site (Report from Phil Bobel). The groundwater treated by the POTW would comply with the ARARs.

**Long-term Effectiveness and Permanence.** There should be no residual risk once the remedial objectives have been met. The target constituents would be treated off-site by the POTW and no residual target constituents would be produced on-site. Groundwater monitoring should be continued for a pre-determined period of time to ensure no constituents remain in the aquifer.

**Reduction in Toxicity, Mobility, and Volume.** The toxicity, mobility, and volume of target constituents would be reduced by removing the groundwater and preventing further migration of constituents. The groundwater would be extracted and discharged to a POTW. The POTW would treat the groundwater to meet their effluent requirements.

**Short-term Effectiveness.** The implementation of this process poses no threat to the environment or the health of the community or JASCO employees. There is no exposure to the public. The groundwater would be extracted and discharged directly to the POTW. It is estimated that remedial objectives would be met within 10 years.

**Implementability.** This alternative is implementable and currently in use. One well is extracting 2 gallons per minute or less of groundwater which is discharged to a POTW. An extraction system, consisting of additional wells, may have to be installed to control potential target constituent plumes emanating from the site. This is a reliable process. The current process has operated without problems since 1987.

**Cost.** The capital cost would be \$30,000 for the extraction system. The discharge cost of this treatment is \$1.25 per 100 cubic feet of groundwater (Phil Bobel, Environmental Compliance Division, Public Works Department, City of Palo Alto). Assuming an extraction system operating at 6 gpm for 365 days a year, the annual cost for discharge would be \$5,500. In addition, monthly analysis of the groundwater is required using EPA Method 601/602. This would be an annual cost of \$1,500. Total annual cost would be \$7,000. The present worth of this alternative would be \$72,000 based on a 10-year remediation life and 10% discount rate.

**State and Community Acceptance.** If the discharge limits can be consistently met and the source of target constituents is removed, the State and community should accept this alternative.

This alternative poses no health threat to the public and should be accepted by the community. This alternative has been selected as the remedy at CTS Printex, another Superfund site in Mountain View.

### 3.1.3 Alternative III: UV Oxidation

This remedial alternative consists of extracting the groundwater and treating it using UV oxidation. UV oxidation treatability studies have been performed on groundwater with similar target constituents from another Superfund site in San Jose, California. During these studies UV oxidation successfully destroyed chlorinated solvents and no additional treatment process was necessary for polishing.

The advantage of using UV oxidation is the destruction of the target constituents rather than transferring them from one media to another. However, this process is fairly sophisticated. Because of this, it is more costly, requires more time to set up, and more attention to maintain. A holding tank would be required because of the low flowrate. The treatment would operate on a batch basis. When enough groundwater has been collected, the system would be operated until the holding tank had been emptied. Treated groundwater would be discharged to the city sewer line under a POTW permit. The volume of groundwater that would be treated annually under this alternative would range from 790,000 gallons to 3,160,000 gallons depending on remedial design and site hydrogeology.

There is the potential to produce toxic byproducts that are not totally oxidized. OHM recommends, and the vendors of the process require, an operational treatability study. A treatability study would evaluate UV oxidation's performance on JASCO's site groundwater. This would help to optimize the process for JASCO's site conditions.

**Overall Protection of Human Health and Environment.** This alternative provides for the overall protection of human health and environment by destroying the target constituents in the groundwater. The constituents would be permanently destroyed over the longterm. However, a treatability study should be performed prior to implementation to ensure no toxic by-products are produced from the process. Migration of the constituents would be controlled to prevent degradation of drinking water sources. The toxicity, mobility, and volume of the target constituents would be reduced. The implementation and operation of the system would not pose a threat to human health or the environment.

**Compliance with ARARs.** Under this alternative, groundwater containing target constituents above MCLs would be extracted. The extraction process would also prevent migration of target constituents. UV oxidation has been shown to destroy many of the target constituents present in the extracted groundwater to comply with ARARs, although it does not degrade 1,1,1-TCA as effectively as saturated chlorinated hydrocarbons.

**Long-term Effectiveness and Permanence.** If treatability studies demonstrate that ARAR's can be met and after the response objectives have been met, there should be no remaining risk to human health or environment. The process should not produce toxic residual compounds; however, treatability tests are recommended to determine exactly what the byproducts will be. The destruction of the target constituents by UV oxidation is a permanent process.

**Reduction in Toxicity, Mobility, and Volume.** Past treatability studies have demonstrated that UV oxidation is capable of destroying the types of target constituents present at JASCO

(Waterworld News, Vol. 3, No. 3, May/June 1987). This treatment would reduce the toxicity, mobility, and volume of target constituents. The UV oxidation process would provide toxicity and volume reduction by permanently destroying the constituents. The mobility of the constituents would be reduced by the extraction system. It would be designed to capture the migration plume.

**Short-term Effectiveness.** The implementation of this process would pose no health threat to the community or JASCO workers. It also poses no threat to the environment. No target constituents would be released to the atmosphere. Groundwater would be contained within the system until it was treated. Once treated, the groundwater would be disposed of off-site by discharging to a POTW. This alternative would result in a reduction in the concentration of target constituents over the short term. Eventually the rate of decrease in concentration would slow down and level off at some concentration. It is estimated the remedial objectives may be met in approximately 10 years.

**Implementability.** This alternative is moderately difficult to implement. The UV oxidation equipment is fabricated off-site and delivered to the site. The difficulty arises from fine-tuning the system to perform optimally. Vendors of UV oxidation claim their systems are reliable and they provide technical support to maintain the operation. Experience indicates that there can be considerable operational and quality problems, especially if the wastewater stream concentrations are inconsistent.

**Cost.** The capital costs are as follows:

UV Oxidation Equipment -	\$140,000
Equalization Tank -	\$ 6,000
Treatability Study -	\$ 5,000
Start-up Cost -	\$ 5,000
Groundwater Extraction System -	<u>\$ 30,000</u>
TOTAL CAPITAL COST -	\$186,000

A treatability study is required by the vendor of this technology. The start-up cost associated with this system is for a field engineer to set-up the system. The cost of a field engineer is \$2,000 for the first week and \$500 for each additional day. Travel cost and expenses have not been included in this cost.

The annual operating costs associated with operating the UV system are as follows:

Process Chemicals & Utilities -	\$ 4,000
Labor -	\$20,000
Discharge to POTW -	<u>\$ 7,000</u>
TOTAL ANNUAL OPERATING COST -	\$31,000

The process chemicals and utilities are based on a vendor quote of \$1.20 per 1000 gallons of water treated. The capital cost and operating cost of the UV oxidation equipment are provided by Ultrox International. Since JASCO will cease operations at this location in the future, labor costs have been included to maintain the system and perform monitoring. System maintenance would be performed by the vendor.

No additional land or site development would be necessary. Since JASCO will cease operations from this location in the future, labor costs have been included to operate the system on a batch basis. Any technical servicing would be performed by the vendor at additional cost.

Assuming a 10-year remediation life and a 10 percent discount rate, the present worth of the project would be \$370,000.

**State and Community Acceptance.** The State and community would most likely be willing to accept this alternative. It has been accepted by the California Regional Water Quality Control Board for a site in San Jose, California. The operation of the system would not disturb the local residents nor be dangerous to them.

#### 3.1.4 Alternative IV - Liquid Phase Carbon Adsorption

In this alternative, the groundwater is extracted and then treated by passing it through a liquid phase carbon adsorption bed. The target constituents are adsorbed by the carbon, which is then taken off-site for regeneration. A carbon vendor will perform the regeneration by incineration. The regeneration process will destroy the target constituents. The treated groundwater is discharged to the city sanitary sewer under a POTW permit. The volume of groundwater that would be treated annually under this alternative would range from 790,000 gallons to 3,160,000 gallons depending on remedial design and site hydrogeology.

The advantage of this system is that it is easily implementable and requires little attention to maintain. "Off the shelf" units can be placed in-line to implement this alternative. Maintenance consists of monitoring the effluent to determine when the carbon units need to be replaced. This process does not, however, destroy the target constituents until the carbon is regenerated; it merely transfers them from the groundwater to the carbon. When the carbon becomes saturated, the carbon vendor replaces the old carbon with new carbon. The old carbon will be regenerated by the vendor.

**Overall Protection of Human Health and Environment.** This alternative provides for the overall protection of human health and environment. The target constituents would be permanently removed over the long term. Migration of the target constituents in the aquifer would be controlled to prevent degradation of drinking water sources. The toxicity, mobility, and volume of the target constituents would be reduced. The operation of the system would not pose a threat to human health or the environment.

**Compliance with ARARs.** Under this alternative, groundwater containing target constituents above MCLs would be extracted. The extracted groundwater would be treated by carbon to remove the target constituents from the extracted groundwater to comply with the ARARs. The treated groundwater would meet the discharge requirements under JASCO's POTW permit. The extraction process would also prevent migration of target constituents.

**Long-term Effectiveness and Permanence.** Once the remedial objectives had been met, there would be no residual risk. The process would produce no residual compounds. Removal of the target constituents by carbon is permanent. Monitoring should be continued for a period of time to ensure no target constituents remains in the aquifer.

**Reduction of Toxicity, Mobility, and Volume.** Carbon would absorb the target constituents present in the groundwater. It is expected that this treatment would remove the target

constituents to a non-detectable level. This process is permanent and does not produce residual compounds. The toxicity of the target constituents would not be reduced by this method. Once the carbon was regenerated by incineration, the toxicity would be reduced. The mobility is reduced by the extraction system. The extraction system would be designed to capture the groundwater. The volume of target constituents present in the aquifer would be reduced as the groundwater was treated.

**Short-term Effectiveness.** The implementation of this process poses no risk to the environment or the health of the community or JASCO workers. No target constituents would be released to the atmosphere. Groundwater would be contained within the system. The treated groundwater would be disposed of by discharging to a POTW. Spent carbon would be taken off-site for regeneration. This alternative would produce a reduction in the concentration of target constituents in the short term. Eventually the rate of decrease in concentration would slow and level off. It is estimated that remedial objectives might be met in approximately 10 years.

**Implementability.** This alternative is implementable. The carbon units are "off the shelf" units which are piped into the extraction system. Because carbon adsorption is a relatively simple process, it should be fairly reliable. Effluent would have to be monitored for breakthrough of target constituents. Once there is breakthrough, the unit would be taken out of service and another unit placed on-line. The old carbon unit is regenerated by the carbon vendor. The effectiveness of this alternative is not affected by the low flowrate.

**Cost.** It is difficult to predict the carbon usage at this time since the concentration of target constituents have not remained constant. For estimating cost, water quality data from January 1992 will be used. This data indicates the highest target constituents are diesel fuel and 1,1-dichloroethane (1,1-DCA); except for paint thinner, the other constituents are well below the 0.75 ppm limit. 1,1-DCA will be used here to estimate carbon usage. Additional information (i.e., exact diesel fractions present) would need to be gathered concerning the diesel constituent to determine carbon usage.

At the January 1992 1,1-DCA concentration (0.61 mg/L), the carbon usage would be 1.82 lb per 1,000 gallons. The daily usage will be 16 pounds of carbon. Based on this usage rate, the carbon unit chosen for this alternative is the 350 gallon Calgon Disbosorb. This unit contains 2,500 pounds of carbon and costs \$4,200. The cost to dispose of a unit is \$2,000. At the calculated usage, JASCO will use two of these carbon units annually.

The cost of this alternative is:

Groundwater Extraction System -	\$30,000
Two Initial Carbon Units -	<u>\$ 8,400</u>
TOTAL CAPITAL COST -	\$38,400

The annual operating costs are:

Carbon Disposal -	\$ 6,000
Carbon Unit Replacement -	\$16,800
Labor -	\$ 3,000
Discharge to POTW -	<u>\$ 7,000</u>
TOTAL ANNUAL OPERATING COST -	\$32,800



Assuming a 10-year remediation life and a 10 percent discount rate, the present worth of the project would be \$236,000. Since JASCO will cease operations at this location in the future, labor costs have been included to maintain the system and perform monitoring.

This cost is based on operating two units in series. This is the typical method of implementing carbon units. By operating in series, no target constituents will be discharged into the effluent after breakthrough of the first (or lead) carbon unit. Once breakthrough from the lead unit is detected, the second (or lag) unit is placed into service as the lead unit and a fresh unit is placed into service as the lag unit.

**State and Community Acceptance.** The State and community would most likely be willing to accept this alternative. The operation of the units would not disturb the local residents nor be dangerous to them.

### 3.1.5 Alternative V: Air Stripping

This alternative consists of extracting the groundwater and treating it by air stripping. Treated groundwater would be discharged to the POTW. The volume of groundwater that would be treated annually under this alternative would range from 790,000 gallons to 3,160,000 gallons depending on remedial design and site hydrogeology. Air stripping of groundwater at JASCO appears to be exempt from emissions control. According to the Bay Area Air Quality Management District's (BAAQMD) regulations (Regulation 8, Rule 47), if an air stripping operation emits less than 1 pound per day of benzene, vinyl chloride, perchloroethylene, methylene chloride, and/or trichloroethylene, it is exempt from emissions control. At this time, if all the target constituents in the groundwater were removed by airstripping (at a influent rate of 6 gpm), it would not emit more than 1 pound per day of the listed constituents (refer to calculations). This alternative transfers the target constituents from the groundwater to the air where they will degrade over time.

If emissions control is needed, the options are passing the air effluent through a carbon bed or through a catalytic oxidizer. If passed through carbon, the volatilized organics would be adsorbed onto the carbon. If passed through a catalytic oxidizer, the volatilized organics would be converted to carbon dioxide and water (for organic compounds) or hydrogen chloride, carbon dioxide, and water (for chlorinated hydrocarbons).

**Overall Protection of Human Health and Environment.** This alternative provides for the overall protection of human health and environment. The target constituents would be permanently removed or destroyed over the long-term. The toxicity, mobility, and volume of the target constituents would be reduced. The operation of the system would pose no threat to human health or the environment. Air emissions would be low and not be considered a health threat.

**Compliance with ARARs.** Under this alternative, groundwater containing target constituents above MCLs would be extracted. Most target constituents in the extracted groundwater could be removed by air stripping to comply with the ARARs. The one constituent which may not be removed by air stripping is diesel fuel. Based on January 1992 data, the concentration of this compound is 0.63 mg/l. This concentration does not exceed the POTW permit and would comply with the ARARs. The treated groundwater would meet the discharge requirements under JASCO's POTW permit.

Air emissions would be less than 1 lb. of benzene, vinyl chloride, perchloroethylene, methylene chloride, and/or trichloroethylene. This would satisfy the requirements for an exemption from BAAQMD's air stripper regulations.

**Long-term Effectiveness and Permanence.** Once the remedial objectives have been met, there should be no residual risk. The process should produce no residual compounds. Monitoring should be continued for a period of time to ensure no target constituents remains in the aquifer.

**Reduction of Toxicity, Mobility, and Volume.** The target constituents present in the groundwater would be removed by air stripping. It is expected that this treatment would remove the target constituents to a non-detectable level in the treated groundwater. This process is permanent and does not produce residual compounds. The natural degradation of the target constituents would reduce the toxicity. The mobility would be reduced by the extraction system. The extraction system would be designed to capture the groundwater. The volume of target constituents present in the aquifer would be reduced as the groundwater was treated.

**Short-term Effectiveness.** The implementation of this process poses no health threat to the community or JASCO workers and poses no risk to the environment. Air emissions would comply with regulations enforced by the BAAQMD. Groundwater would be contained within the system. The treated groundwater would be disposed of off-site by discharging to a POTW. This alternative would produce a reduction in the concentration of target constituents in the short term. Eventually the rate of decrease in concentration would slow and level off at some concentration. It is estimated the remedial objectives might be met in approximately 10 years.

**Implementability.** This alternative is implementable, although the groundwater flowrates are very low for standard air strippers. The air stripping tower and catalytic oxidizer would be fabricated off-site and delivered to the site. The low flowrate will require this treatment be operated on a batch basis. This will require a holding tank and an automated system to control the air stripper.

Compliance with BAAQMD's Regulation 8, Rule 47 will need to be provided to BAAQMD (i.e., air emissions do not exceed 1 pound per day of chemicals previously stated) to obtain an exemption. If JASCO does not qualify for an exemption, an air permit must be obtained and emission controls installed on the air stripper.

**Cost.** The capital costs are as follows:

Air Stripping Tower w/ automatic control -	\$10,000
Equalization Tank -	\$ 6,000
Extraction System -	<u>\$30,000</u>
TOTAL CAPITAL COST -	\$46,000

The annual operating costs associated with operating the air stripper system are as follows:

Utilities -	\$2,000
Labor -	\$3,000
Discharge to POTW -	<u>\$7,000</u>
TOTAL ANNUAL OPERATING COST -	\$12,000

The utility cost would be for the air blower. Since JASCO will cease operations at this location in the future, labor costs have been included to maintain the system and perform monitoring.

Assuming a 10-year remediation life and a 10 percent discount rate, the present worth of this alternative would be \$118,000. The present worth of this alternative would increase \$200,000 if the air effluent were treated by carbon adsorption and \$180,000 if the air effluent were treated using a catalytic oxidizer.

**State and Community Acceptance.** The State would most likely be willing to accept this alternative. It has been chosen as a treatment remedy at other sites in the Santa Clara Valley.

### 3.1.6 Alternative VI: Biological Treatment followed by Carbon Adsorption

This alternative consists of extracting the groundwater and biologically treating it to destroy the majority of non-chlorinated compounds. Carbon would follow the initial biological treatment to remove target constituents (such as TCE and DCE) which may not have biodegraded. Biodegradation of chlorinated hydrocarbons, if complete, would produce carbon dioxide, water, salt, chlorine ions, and/or hydrogen chloride. Treatability studies would have to be performed to determine to what extent the target constituents present could be biodegraded and, consequently, how much carbon would be required. Treatability studies would be required to optimize biological treatment and carbon adsorption to meet the ARARs.

The advantage of this alternative, if effective, would be the immediate destruction of many of the higher-concentration constituents. The microorganisms would biologically degrade many of the target constituents. However, the biological treatment of some of the chlorinated compounds present is unproven. Liquid phase carbon would most likely provide the means for removing most of the chlorinated compounds.

Sludge produced from the biological process will be analyzed and disposed of appropriately. Carbon from the process will be regenerated by a permitted facility. Treated groundwater will be disposed to the POTW. The volume of groundwater that would be treated annually under this alternative would range from 790,000 gallons to 3,160,000 gallons depending on remedial design and site hydrogeology. This alternative would comply with the ARARs.

**Overall Protection of Human Health and Environment.** This alternative provides for the overall protection of human health and environment. Compounds which are not biologically degraded will be adsorbed onto the carbon. The target constituents would be permanently removed over the long-term, either by bioremediation or carbon adsorption. Migration of the target constituents would be controlled to prevent degradation of drinking water sources. The toxicity, mobility, and volume of the target constituents would be reduced. The operation of the system would be totally enclosed, so would pose no threat to human health or the environment.

**Compliance with ARARs.** The target constituents in the extracted groundwater would either be biodegraded or removed by carbon adsorption to comply with the ARARs.

**Long-term Effectiveness and Permanence.** Once the remedial objectives have been met, there should be no residual risk. If the bioremediation process produced toxic intermediate products, they would most likely be adsorbed on the carbon beds. A treatability study would help to better define any intermediate products. Biodegradation of chlorinated hydrocarbons, if complete, would produce carbon dioxide, water, salt, chlorine ions, and/or hydrogen chloride.

There would not be any bio-accumulation of organics within the microorganisms. The sludge from the process will be analyzed to verify this. The sludge will be disposed of properly based on analytical results. The removal of the target constituents by carbon is permanent. Monitoring should be continued for a pre-determined period of time to ensure no target constituents remains in the aquifer.

**Reduction of Toxicity, Mobility, and Volume.** The biodegradation process would reduce the toxicity and volume of organic hydrocarbons. The extent of biodegradation of the chlorinated organics would need to be determined in a treatability study. However, if these chlorinated compounds are determined to be non-biodegradable, carbon would absorb them. The mobility is reduced by the extraction system. The extraction system would be designed to capture the groundwater. The volume of target constituents present in the aquifer would be reduced as the groundwater was treated, either by biological processes or by carbon adsorption.

**Short-term Effectiveness.** The implementation of this process poses no risk to the environment or to the health of the community or JASCO workers. No target constituents would be released to the atmosphere. Groundwater would be contained within the system. The treated groundwater would be disposed of off-site by discharging to a POTW. This alternative would produce a reduction in the concentration of target constituents in the short term. Eventually the rate of decrease in concentration would slow and level off. It is estimated the remedial objectives might be met in approximately 10 years.

**Implementability.** This alternative is implementable. Biological treatment would require a reactor vessel to contain the microorganisms necessary for the process. These reactor vessels could be fabricated off-site. The carbon units are "off-the-shelf" units which are piped into the extraction system. The reliability of the system would depend on the complexity of the biological treatment. With biotreatment systems, there is always a potential for upsets due to temperature, pH, concentration, or other system shocks.

Effluent from the carbon beds would have to be monitored for breakthrough of target constituents. Once there is breakthrough, the unit would be taken out of service and another unit placed on-line. The old carbon unit would be regenerated by the carbon vendor.

**Cost.** The capital costs are as follows:

Biological Reactor -	\$51,000
Two liquid phase carbon units -	\$ 8,400
Groundwater Extraction System -	<u>\$30,000</u>
TOTAL CAPITAL COST -	\$89,400

The annual operating costs associated with operating the biological treatment system are as follows:

Process Chemicals & Utilities -	\$ 3,000
Labor -	\$ 2,000
Carbon Unit Replacement -	\$0 to \$8,400
Carbon Regeneration -	\$0 to \$4,000
Discharge to POTW -	<u>\$ 7,000</u>
TOTAL ANNUAL OPERATING COST -	\$12,000 to \$24,400

The process chemicals and utilities are estimated. The range of carbon regeneration is based on total biodegradation and no biodegradation. The carbon units priced here are the same disposable units described in Alternative III.

Since JASCO will cease operations at this location in the future, labor costs have been included to maintain the system.

Assuming a 10-year remediation life and a 10 percent discount rate, the present worth of the project would range from \$162,000 to \$236,000.

**State and Community Acceptance.** The State and community would most likely be willing to accept this alternative. The operation of the units would not be dangerous to the local residents nor disturb them.

### 3.2 SOIL REMEDIAL ALTERNATIVES

Soil remediation alternatives are listed below. Approximately 1,100 cubic yards of soil from the former drainage swale area and former diesel fuel storage area will have to be treated or disposed (see Section 1.2.3 for volume estimate). An unknown volume of additional soil may require treatment when the underground tanks are removed.

#### Soil Remedial Alternative I: No Action

- No Action

#### Soil Remedial Alternative II: Off-site Treatment

- Deed Restrictions
- Excavation
- Off-site RCRA Treatment and/or Disposal

#### Soil Remedial Alternative III: Enhanced Biological Treatment

- Deed Restrictions
- Soil Excavation
- Enhanced Biological Treatment
- On-site Replacement

#### Soil Remedial Alternative IV: X-19 Biological Treatment

- Deed Restrictions
- Soil Excavation
- X-19 Treatment
- On-site Replacement

#### Soil Remedial Alternative V: Excalibur Process

- Deed Restrictions
- Soil Excavation
- Soil Washing (Excalibur Process)
- On-site Replacement

The alternatives which list on-site replacement of the soil assumes that the soil can be treated to comply with ARARs and will meet or be exempt from land ban restrictions. At present the treated soil would be exempt from such restrictions at least until May of 1993. On-site treatment

technologies could be implemented within this exemption period. Additional restrictions and modifications of the acceptable disposal practices are being considered by regulatory agencies. Because the scope of these changes is unknown, the effect of these regulatory activities on future remedial activities at the Site after May of 1993 cannot be determined at this time.

The excavation of soil from the former drainage swale area is estimated to cost \$200,000. This is unusually expensive because of the nearby railroad tracks. Excavation of this amount of soil would normally cost from \$3,000 to \$8,000 per 100 cubic yards. "Normal" excavation procedures may cause slumping of the soil and damage the nearby railroad tracks. Since damage to these active tracks is unacceptable, excavation of soil in the drainage swale would be performed with a drill rig. Large augers, approximately 36" in diameter, would be used to "drill out" the soil. After the borehole was completed, it would be backfilled with concrete to prevent slumping of adjacent soil. It is estimated that 1,100 cubic yards of soil (see Section 1.2.3.1 for estimated volume) would be excavated from the drainage swale area and treated. The estimated cost of excavation (\$200,000) is based on identical excavation operations performed previously in the former drainage swale area. The cost includes mobilizing the equipment, "drilling out" the soil, backfilling the boreholes, and demobilization. The cost of treatment alternatives are based on treating 1,100 cubic yards of soil.

The preferred treatment approach would be an in-situ process, such as vapor extraction or bioremediation, to avoid the high cost of excavation. These will not be considered at this time because soil characteristics at JASCO (clay with sand) are inappropriate for vapor extraction. Clays have very low permeabilities and sands have very high permeabilities. If vapor extraction were used, air would be drawn through the sand preferentially and have little effect on the target constituents held within the clays. There is a possibility in-situ bioremediation may be successful. Treatability studies would have to be conducted to determine the effectiveness of in situ bioremediation.

For the alternatives where on-site treatment is performed, the soil will be placed back on-site. The soil remediation objective concentrations are low enough to satisfy the land ban treatment requirements and soil replacement on-site could be performed.

### 3.2.1 Alternative I: No Action

As with Groundwater, the No Action option must be retained. No treatment would be implemented and the soil would simply be left in place.

**Overall Protection of Human Health and Environment.** Under the current land-use, implementation of this alternative would not directly endanger public health. This alternative does not provide protection for the environment. Target constituents could migrate from soil to groundwater and might further degrade the groundwater quality.

All current and potential future risks would remain with this alternative. The Jacobs Endangerment Assessment has demonstrated that "contaminants detected at the Jasco site pose no threat to the public health under current land-use conditions. However potential future land-use scenario are described which could pose higher health risks." The future land-use scenario described entail direct ingestion of the A-aquifer groundwater.

**Compliance with ARARs.** This alternative could eventually comply with the ARARs through naturally-occurring processes such as biodegradation, diffusion, and abiotic degradation. The time required to accomplish this is not known but would likely be a number of decades.

**Long-term Effectiveness and Permanence.** The natural degradation of the target constituents which would occur over the decades would be permanent. However, as this natural degradation occurs, the population at risk could increase if the target constituents migrate to the groundwater.

**Reductions in Toxicity, Mobility, and Volume.** This alternative would not reduce the toxicity or mobility of the target constituents in the short term. The volume of target-constituent-containing material would increase because of diffusion and leaching of the constituents.

**Short-term Effectiveness.** "No Action" would not be effective in the short-term. The natural degradation of the target constituents is a very long-term process.

**Implementability.** This alternative would require no effort to implement.

**Cost.** There would be no cost required to implement this alternative.

**State and Community Acceptance.** It is not likely that the State or community would accept this alternative.

### 3.2.2 Alternative II: Off-site Treatment

Soil containing target constituents would be excavated and transported off-site for treatment and disposal at a RCRA permitted facility.

Treating and disposing of the soil off-site has the advantage of removing soil containing target constituent from the site. However, JASCO would still be responsible for the soil. This is an expensive alternative. The soil would most likely have to be transported out of state for incineration since there are no incinerators in California.

**Overall Protection of Human Health and Environment.** This alternative provides for the overall protection of human health and environment. The soil would be properly treated and disposed of by a RCRA permitted facility. The treatment would most likely be incineration which would permanently destroy the target constituents. The toxicity, mobility, and volume of target constituents would be reduced. Precautions would be taken to reduce the amount of the airborne constituents during excavation of soil to prevent exposure to workers and nearby residents. There is always a risk associated with transporting hazardous material off-site since there is the potential for a spill, accident, or future liability at the TSD facility.

**Compliance with ARARs.** This alternative would comply with the ARARs. Target constituents would be removed from the site and be totally destroyed by off-site treatment.

**Long-term Effectiveness and Permanence.** There would be no residual risk at the site. On-site, there would be no byproducts of this treatment alternative. At the treatment facility, the incineration would reduce the target constituents to non-toxic compounds. This alternative offers permanent removal of the target constituents.

**Reductions in Toxicity, Mobility, and Volume.** Since the target constituents would be removed from the site and destroyed, the toxicity, mobility, and volume would be reduced with this alternative.

**Short-term Effectiveness.** There is a risk that excavation of soil could produce airborne particulates. Dust suppression would be practiced during excavation to prevent particulates from becoming airborne. No other risk to human health or environment would exist during implementation of this alternative at the site. This alternative could be completed in less than six months.

**Implementability.** This alternative would not be difficult to implement. A TSD facility would have to be located that would accept the soil and the soil would need to be properly manifested for transportation.

**Cost.** Off-site treatment of the soil would most likely be necessary prior to disposal. The off-site treatment would be incineration.

Excavation -	\$ 200,000
Transportation -	\$ 93,000
Treatment & Disposal -	<u>\$1,390,000</u>
TOTAL -	\$1,683,000

Transportation costs are based on \$50 per hour per truck. It would take 62 truckloads 30 hours (portal to portal) to transport all the soil. The cost for treatment and disposal is \$0.45 per pound of soil. The cost for disposal could decrease to \$400 per ton if no incineration is required.

**State and Community Acceptance.** This alternative would most likely be accepted by the State and community. The alternative could be safely implemented and target constituents would be removed leaving no health risk to the local population.

### 3.2.3 Alternative III: Enhanced Biological Treatment

Soil containing target constituents would be excavated, prepared, and placed in a totally enclosed reactor vessel (which might consist of soil contained between sealed liners) for enhanced biological treatment. Preparation of the soil would consist of mixing the soil and adding a bulking agent and nutrients for the microorganisms. Mixing the soil and adding in a bulking agent aids the process by making the soil more permeable to air and water. Indigenous microorganisms could be used, or specialized microbial consortia could also be added. The activity of the microorganisms would be increased by the addition of nutrients.

The reactor vessel would have an air distribution system along the bottom. Air would be drawn through this distribution system to provide oxygen to the microorganisms and to simultaneously extract volatile organics. This air stream is passed through carbon to adsorb volatile organics which are extracted from the soil. This process is suited for the mixture of target constituents at JASCO. The chlorinated hydrocarbons, which are not easily biodegraded, are volatile and would be extracted by the air and adsorbed on carbon. The heavier hydrocarbons, which are less volatile, would be biodegraded.

This is similar to vapor extraction, only performed ex situ. This is a better application than in-situ vapor extraction because the soil is homogenized for better air flow through the soil.



This alternative would provide a cost-effective option to biologically destroy the non-volatile target constituents (and some of the volatiles as well) and to adsorb volatile compounds onto carbon beds. This alternative is expected to be effective. Upon successful completion of the treatment phase the soil would comply with ARARs and be left on-site.

**Overall Protection of Human Health and Environment.** It is expected that operation of this process would not pose a threat to human health or environment. Chlorinated compounds would be adsorbed on carbon and the other target constituents, as well as some of the chlorinated compounds, would be biodegraded.

**Compliance with ARARs.** This alternative would most likely meet ARARs. Organic hydrocarbons have been shown to be biodegradable. Chlorinated hydrocarbons are less biodegradable, but are very volatile. These volatile compounds would be adsorbed in the carbon beds.

**Long-term Effectiveness and Permanence.** This alternative would provide long-term effectiveness and permanence since the target constituents would either be removed from the soil, or biodegraded.

**Reduction of Toxicity, Mobility, and Volume.** Enhanced biological treatment would provide a reduction in toxicity, mobility, and volume of target constituents.

**Short-term Effectiveness.** Proper implementation of this alternative would pose no threat to the community, JASCO workers, or the environment. Dust suppression would be practiced during excavation to prevent particulates from becoming airborne. No other risk to human health or environment would exist during implementation of this alternative. This alternative could be completed in less than 2 years.

**Implementability.** This alternative is implementable. OHM and other companies have implemented this type of process. Once all the preparation has been completed, it requires little attention. Carbon canisters would need to be monitored for breakthrough of target constituents.

**Cost.** The cost for this alternative would be:

Excavation -	\$200,000
Treatment -	<u>\$165,000 to \$248,000</u>
TOTAL -	\$365,000 to \$448,000

The total cost range of this alternative reflects a cost of \$150 to \$225 per cubic yard of soil and is based on past experience.

**State and Community Acceptance.** The State and community would most likely accept this alternative. The implementation and operation of the process would not pose a threat to human health or environment. The microorganisms used would most likely be those which are native to the soil, so would pose no threat to human health or environment. If non-native microorganisms are used, they would be naturally occurring and not engineered. It would also provide permanent destruction, or removal by carbon adsorption of the target constituents.

### 3.2.4 Alternative IV: X-19 Biological Treatment

Soil containing target constituents would be excavated and treated using the X-19 amendment process. The X-19 process has been proven to effectively biodegrade petroleum hydrocarbons and other organics that are readily biodegradable. The developer has presented information that suggests that the microbial consortium in X-19 is capable of degrading more recalcitrant chlorinated organics as well. However, to date the process has not been tested using an EPA-approved protocol or other enclosed bioreactor study with a detailed mass balance. There are indications that this process could indeed be effective, but it would be necessary to conduct an EPA-protocol treatability study to demonstrate that the chlorinated compounds were indeed being biodegraded.

This process would be applied by mixing the X-19 additive into the soil in a controlled manner (with water) to avoid volatilization of the target constituents, while also mixing in any nutrients required. The soil would then be placed either on a liner, securely covered with an additional liner/cover, or all of the soil would be placed in a secure treatment vessel. The vendor states that within several months, the microorganisms will have completed their work of degrading the organics to non-detectable levels. If this process is effective, it will require minimal handling and attendance and the soil would remain on-site or be reused on-site as a soil amendment after treatment was complete.

**Overall Protection of Human Health and Environment.** This process would be protective of human health and the environment as long as it was contained (to eliminate any emissions) and it was effective in degrading all target constituents. The only potential for exposure would be during the initial excavation and the final soil removal (if the target constituents were not destroyed). During excavation moisture would be added to the soil to minimize the emissions. It would simultaneously provide the moisture required for bioremediation to occur. The organisms used are naturally occurring and non-genetically engineered organisms.

**Compliance with ARARs.** Compliance with ARARs cannot be demonstrated without performing a treatability test. With bioremediation the cost of treatment increases substantially as one decreases the cleanup criteria. Although the vendor has claimed that non-detectable levels can be achieved, experience indicates that treatment of extremely low levels of target constituents requires a primary substrate to sustain the microbial culture. The microbes will then continue to consume the target constituents as a secondary food source.

**Long-term Effectiveness and Permanence.** Those target constituents that could be biodegraded would be permanently biodegraded. It is unknown whether the chlorinated compounds would be completely biodegraded. There is a possibility that biodegradation would continue to take place beyond the initial treatment period. Most of the biodegradation would be completed in the soil pile within a relatively short period (less than one year) while controlled treatment was being conducted.

**Reductions in Toxicity, Mobility, and Volume.** This process should reduce the above characteristics for the non-chlorinated target constituents present. However, it is unknown to what extent it would reduce these characteristics for the chlorinated organic target constituents. Only a detailed treatability study can provide this information for the soil matrix and specific target constituents present.

**Short-term Effectiveness.** If this process is effective, whatever degradation occurs should be completed within one year, so it would provide short-term effectiveness for those target constituents it is capable of degrading.

**Implementability.** This process would be fairly easy to implement at the Jasco site in Mountain View. Whether the liner approach or contained bioreactor approach was used, treatment could be conducted at the site. There appears to be adequate space available for on-site treatment since the volume of soil to be treated is relatively small (approximately 1,100 CY). If the soil volume exceeded the quantity that could be practically treated at one time, the soil could be treated in stages, although JASCO prefers to treat the soil in the shortest time period possible, considering the future land use.

**Cost.** The cost for this alternative would be:

Excavation -	\$200,000
Soil handling -	\$ 30,000 to \$50,000
X-19 Consortium -	\$ 18,500
EPA Treatability Study -	<u>\$ 30,000 to \$50,000</u>
TOTAL -	\$278,500 to \$318,500

The per ton cost of X-19 is \$50. Assuming a 3:1 volume mixture of soil to X-19 and a density of 1 ton per cubic yard, 370 tons of material would be used.

**State and Community Acceptance.** Bioremediation processes tend to be accepted by regulatory agencies and communities if the microorganisms used are not genetically engineered or otherwise dangerous to human health. Considerable resistance would not be expected provided: 1) the process was contained; 2) it could be proven that the microorganisms did not present any health danger and; 3) the hazardous compounds were controlled during excavation, mixing and placement.

### 3.2.5 Alternative V: Excalibur Process

This alternative has been included because preliminary results have indicated that ultrapure water is very effective in dissolving all types of target constituents in soils, from sand through clay. It has been implied that ultrapure water is a "universal solvent". The inventors claim that ultrapure water, in combination with UV ozonation and ultrasound, is much more effective than traditional UV oxidation processes in destroying a mixture of organic compounds. There is not extensive data available on this process, since it is a fairly new and innovative process. It may be beneficial to perform a treatability study to further evaluate this process, dependent upon the results of this feasibility study. This is a very innovative technology and would require treatability testing without any assurances that the process would be viable. Upon successful completion of the treatment phase the soil would comply with ARARs and be left on-site.

**Overall Protection of Human Health and Environment.** If this process is shown to be effective, it would protect the environment by removing and destroying the target constituents present, rather than only transferring them to another media. There would be a minor risk associated with the operation of a small ozone-generating system in a residential neighborhood, so the system's safety controls would have to be thoroughly reviewed and approved.

**Compliance with ARARs.** The vendors of the Excalibur process claim it would be capable of treating the soil to comply with the ARARs. They recommend a treatability study to confirm the effectiveness.

**Long-term Effectiveness and Permanence.** If effective, this system would permanently destroy organic constituents during the on-site treatment operation. The pertinent question relates to the level of decontamination that could be achieved and whether this process would destroy all of the target constituents of concern that are present. This can only be determined by conducting a treatability and/or pilot study.

**Reductions in Toxicity, Mobility, and Volume.** This option would reduce all of the above properties by destroying the organic constituents. The extent to which this process could reduce these properties for the target constituents present in the JASCO soil is unknown.

**Short-term Effectiveness.** If this process is demonstrated to be effective (in treatability or pilot tests), it would be effective within the short term since once a fullscale system is built the treatment process could be completed in a relatively short period of time. It is assumed that treatment would be completed within one year or less.

**Implementability.** A mobile treatment skid is available to treat up to five cubic feet of solids per hour. This is a pilot scale system that could not cost-effectively treat the total volume of soil containing target constituents at the Jasco site. Excalibur has not yet built a fullscale treatment system. If they were to develop and build such a treatment system, implementation at the site should be straight-forward, as this would be a short term operation. However, at this time there is no assurance that a fullscale system will be built.

**Cost.** The cost of this alternative would be:

Excavation -	\$200,000
Treatability Test -	\$ 50,000
Treatment -	<u>\$ 88,000 to 220,000</u>
TOTAL -	\$338,000 to \$470,000

The treatment cost is based on an estimated of \$80 to \$200 per cubic yard of material to be treated.

**State and Community Acceptance.** It is likely that the State and community would accept this process because it is very similar to other UV oxidation processes being used at Superfund sites and past precedent has been set to for such a system at a nearby site.

## 4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the alternatives were evaluated with respect to the nine evaluation criteria. The nine criteria as defined in the National Contingency Plan and CERCLA Section 121(b) and 121(c) are:

- o Overall Protection of Human Health and the Environment
- o Compliance with ARARs
- o Long-Term Effectiveness and Permanence
- o Short Term Effectiveness
- o Reduction of Contaminant Toxicity, Mobility or Volume
- o Implementability
- o State Acceptance/Support Agency Acceptance
- o Community Acceptance
- o Cost

The following is a summary of this analysis.

### 4.1 GROUNDWATER REMEDIATION ALTERNATIVES

**Overall Protectiveness.** Alternative I: No Action would provide no additional protection of human health and the environment beyond the present local restrictions on use of A-aquifer groundwater. Expansion of the existing target constituent plume would occur under this alternative. Alternatives II to V would be protective of human health and the environment because each involves the extraction and treatment of constituent-laden groundwater and the containment of the present constituent plume. Alternatives II to V would equally mitigate significant risks to human health associated with the ingestion of A-aquifer groundwater and the inhalation of groundwater vapors. Alternative II involves off-site treatment of extracted groundwater at the POTW. Alternatives III to V involve an on-site treatment step prior to discharge to the POTW.

**Compliance With ARARs.** Alternative I: No Action would not comply with ARARs as the groundwater would continue to contain target constituents at concentrations exceeding MCLs and the potential for migration of target constituents to potable drinking water sources would remain. Alternatives II to V are expected to provide compliance with ARARs. Alternative II: Discharge to POTW, which has been implemented at the Site since 1987, is expected to comply with the existing permit administered by the City of Mountain View based upon recent discharge data. As of April 1992, permit conditions have been exceeded only four times since the system was implemented in 1987 and have not been exceeded since March of 1991. Alternatives III to V will comply with the existing discharge permit because each would incorporate an on-site pretreatment step prior to discharge. The ability of Alternatives II to V to remediate groundwater to MCLs is dependent upon the implementation of soil remedial alternatives and the design of the extraction system. Alternatives II to V would be equally effective at meeting MCLs as each involves the extraction and treatment of constituent-laden groundwater.

**Long-Term Effectiveness.** Alternative I: No Action would be relatively ineffective at long-term reduction of the magnitude of residual risk. The target constituents present could degrade naturally under this alternative although there would be no engineering control of the process and the alternative would not be a reliable method of remediating groundwater. Alternatives II to V would be expected to provide effective long-term reduction of risks through the removal and treatment of affected groundwater and the containment of the constituent plume. Alternative II:

Discharge to POTW is a reliable process that has been in use at the Site since 1987. Alternatives III to V are reliable processes based upon their application at other sites, however, their reliability under Site conditions would be dependent upon system design. The reliability of the carbon adsorption process utilized under Alternative IV (liquid phase) and potentially under Alternative V (air phase) is dependent in part on the interaction between the loading capacities of the target constituent suite. If implemented, each alternative should undergo a five-year review, both to determine the need for further remediation and to establish the effectiveness of the process.

**Short-Term Effectiveness.** There would be no significant risks to on-site workers during the implementation of Alternative I: No Action although the effectiveness at maintaining community protection would be dependent upon the local restrictions on A-aquifer groundwater use. The implementation protocol for Alternatives II to V would be protective of on-site workers and the community. The only potential environmental impact would be the continued drawdown on the A-aquifer required for groundwater containment. A ten-year action time has been estimated for all alternatives involving groundwater extraction although the actual action time required will be dependent upon the implementation of soil remediation alternatives and the variability of maximum sustainable pumping rates.

**Reduction of Toxicity, Mobility and/or Volume.** Alternative I: No Action would provide for no further reduction of the toxicity, mobility and/or volume of target constituents other than that which would occur through normal attenuation and would not satisfy the statutory preference for treatment. Alternatives II to V would provide a reduction of the total mass and volume of target constituents at the Site through the extraction of affected groundwater. Alternatives II to V would also provide for the reduction of toxicity and mobility of target constituents through the treatment processes each will employ. Alternatives II to V involve a off-site treatment step at the POTW after discharge. All target constituents in extracted groundwater under alternatives III to V would be irreversibly destroyed either in the on-site treatment process (e.g. UV Oxidation) or during the regeneration of materials to which the contaminants were transferred on-site (e.g. carbon adsorption). The statutory preference for use of treatment technologies as opposed to removal and disposal technologies would be satisfied under alternatives III to V and may be satisfied under Alternative II depending upon the POTW process.

**Implementability.** Alternative I: No Action would involve no facility construction and would not affect the ability to implement further actions. Alternatives II to V would be relatively easy to construct and operate. Alternative V: Air Stripping could be more difficult to construct if it were to involve a holding tank and an automated system to hold, treat and discharge wastewater. Under the low flowrates that are expected, however, a flow-through system may be utilized which would be as easy to construct as the other alternatives. Alternative III: UV Oxidation would likely be the most difficult to operate due to the difficulties in fine-tuning the system to maintain optimal system performance. Alternatives II to V would not significantly affect the ease of adding additional treatment processes. Each of the alternatives utilize available technologies supplied by vendors that could provide the required equipment, materials and support.

**State and Community Acceptance.** Each of the alternatives would be feasible to implement from an administrative viewpoint. Alternative I: No Action would likely not be acceptable to the state or the community. Alternatives II to V would be expected to be acceptable to the community at their anticipated scope.

**Cost.** There would be no cost for the implementation of Alternative I: No Action. Of the remaining alternatives, Alternative II: Discharge to POTW would be the least costly to implement

with a present worth of \$72,000. This alternative would involve a maximum capital cost of \$30,000 for the potential installation of additional extraction wells and approximately \$7,000 annually for monitoring and discharge costs. The most expensive alternative to implement would be Alternative III: UV Oxidation with a present worth of \$370,000. Capital costs would be approximately \$186,000 with an estimated annual cost of \$31,000. The present worth of Alternative IV: Carbon Adsorption is estimated at \$236,000. The present worth of Alternative V: Air Stripping is \$118,000. The need for treatment of air-effluent is not anticipated under Alternative V, however, if such treatment is necessary the present worth of this alternative would increase by between \$180,000 and \$200,000.

## 4.2 SOIL REMEDIATION ALTERNATIVES

**Overall Protectiveness.** Alternative I: No Action would provide no additional protection of human health and the environment. Further migration of target constituents in soil could occur. Alternatives II and III would reduce risks to human health at the Site through the removal and treatment of affected soil. A treatability study would have to be conducted to determine the effectiveness of Alternatives IV and V at protecting human health. Alternatives II to V would be protective of the environment because each involves the removal of affected soil as well as measures to prevent further migration of target constituents in soil.

**Compliance With ARARs.** Alternative I: No Action would not comply with ARARs, as the affected soil would remain in place with no treatment. Alternative II: Off-Site Discharge would comply with ARARs. Alternative III: Enhanced Bio-treatment would be expected to comply with ARARs based on the biodegradability and volatility of the target constituents. The ability of alternatives IV and V to comply with ARARs would be determined during the treatability study.

**Long-Term Effectiveness.** Alternative I: No Action would be relatively ineffective at long-term reduction of the magnitude of residual risk. The risks associated with the migration of target constituents to groundwater would remain. The target constituents present could degrade naturally under this alternative. There would be no engineering control of the process and the alternative would not be a reliable method of remediating affected soil. Alternatives II to V would be expected to provide effective and permanent long-term reduction of residual risks through the removal of affected soil. Alternatives II, III and IV utilize reliable treatment methods and provide adequate controls. The Excalibur treatment process utilized under Alternative V is a recent development and its reliability is unknown. A five year review would be conducted until soil cleanup standards are met for all areas of the Site.

**Short-Term Effectiveness.** There would be no significant risks to on-site workers under Alternative I: No Action. Dust control may be required during the excavation step of Alternatives II to V to protect against dermal contact and inhalation of dust containing target constituents. No short-term environmental impacts would be expected under alternatives II to V. Under Alternative II: Off-Site Treatment approximately six months would be required to complete the action. Under alternatives III to V, which involve on-site treatment, between one and two years would be required.

**Reduction of Toxicity, Mobility and/or Volume.** Alternative I: No Action would provide for no further reduction of the toxicity, mobility and/or volume of target constituents other than that which would occur through normal attenuation and would not satisfy the statutory preference for treatment. Alternatives II to V would provide a reduction of the total mass, volume and mobility of target constituents at the Site through the excavation, containment and treatment of affected soil.

Target constituents in excavated soil under Alternative II: Off-Site Treatment would be irreversibly destroyed through off-site incineration. Under Alternative III: Enhanced Bio-treatment target constituents would be irreversibly destroyed either during biodegradation or during the regeneration of materials to which the contaminants were transferred on-site (e.g. carbon adsorption). Very low levels of organic constituents may remain in the excavated soil under Alternative III. A treatability study is recommended for Alternatives IV and V to determine their effectiveness at reducing the toxicity, mobility and volume of target constituents in soil. The statutory preference for treatment would be satisfied under alternatives II to V.

**Implementability.** Alternative I: No Action would involve no facility construction and would not affect the ability to implement further actions. Alternatives II to IV would be easy to construct and operate. The ease of constructing and operating Alternative V is unknown because the Excalibur Process was only recently developed. The incineration of affected soil under Alternative II may limit the application of additional actions. Alternatives III to V would not significantly affect the ease of adding additional treatment processes. Alternative II: Enhanced Bio-treatment utilizes available technologies supplied by multiple vendors that could provide the required equipment, materials and support. The number of incineration facilities that could handle Site wastes under Alternative II is limited and only one vendor exists for the X-19 and Excalibur processes under alternatives IV and V.

**State and Community Acceptance.** Each of the alternatives would be feasible to implement from an administrative viewpoint. Alternative III: Enhanced Bio-treatment would meet the substantive requirements for air emissions controls as administered by the Bay Area Air Quality Management District. No air emissions permit would be required. Alternative I: No Action would likely not be acceptable to the state or the community. Alternatives II to V would be expected to be acceptable to the community at their anticipated scope.

**Cost.** There would be no cost for the implementation of Alternative I: No Action. Each of the remaining alternatives include an estimated cost of \$200,000 for the excavation of affected soil. The most expensive alternative would be Alternative I: Off-Site Disposal with an estimated cost of \$1,683,000. Of the alternatives involving on-site treatment, Alternative IV: X-19 Treatment would be the least costly to implement with an estimated cost of between \$278,500 and \$318,500. The estimated cost for Alternative III: Enhanced Bio-treatment would range between \$365,000 and \$448,000 and the estimated cost for Alternative V: Excalibur Treatment would range between \$338,000 and \$470,000.



## TABLES

**TABLE 1.1**  
**MAXIMUM CONCENTRATION OF TARGET CONSTITUENTS**  
**DETECTED IN SOIL SAMPLES,**  
**DRAINAGE SWALE AREA DS-1**

Constituent	Maximum Concentration (mg/kg)	Date	Depth (ft)
1,1-Dichloroethane (1,1-DCA)	3.0	7/90	30'
1,1-Dichloroethene (1,1-DCE)	1.7	7/90	5'
1,2-Dichloroethene (1,2-DCE)	0.015	7/90	25'
1,1,1-Trichloroethane (1,1,1-TCA)	61.0	7/90	5'
Acetone	8.8	5/88	3'
Benzene	0.12	6/90	1'
Bromoform	0.17	7/90	25'
Ethanol	0.7	5/88	3'
Ethylbenzene	0.37	6/90	1'
Isopropanol	76.0	7/90	3'
Methanol	60.0	7/90	3'
Methylene Chloride	4.2	7/90	20'
Toluene	110.0	7/90	5'
Tetrachloroethene (PCE)	4.0	7/90	25'
Trichloroethene (TCE)	0.015	7/90	3'
Total Petroleum Hydrocarbons:			
as Kerosene	10.0	5/88	3'
as Paint Thinner	5.2	5/88	3'
High Boiling Point (bp)	290.0	6/90	1'
Low-Medium bp	6700.0	7/90	5'
Xylene	37.0	7/90	5'

**TABLE 1.2**  
**MAXIMUM CONCENTRATION OF TARGET CONSTITUENTS**  
**DETECTED IN SOIL SAMPLES,**  
**DRAINAGE SWALE AREA DS-2**

Constituent	Maximum Concentration (mg/kg)	Date	Depth (ft)
1,1-Dichloroethane (1,1-DCA)	0.61	5/88	3'
1,1,1-Trichloroethane (1,1,1-TCA)	0.44	5/88	3'
Acetone	100.0	5/88	3'
Benzene	0.0079	6/90	1'
Ethanol	3.4	5/88	3'
Ethylbenzene	1.2	5/88	3'
Isopropanol	164.0	5/88	3'
Methanol	9.0	5/88	3'
Methylene Chloride	6.2	5/88	3'
Methyl Ethyl Ketone	1.9	5/88	3'
Tetrachloroethene (PCE)	0.24	5/88	3'
Toluene	8.2	5/88	3'
Total Petroleum Hydrocarbons:			
as Diesel	14.0	6/87	6'
as Paint Thinner	170.0	5/88	3'
High Boiling Point (bp)	48.0	6/90	1'
Low-Medium bp	1.4	6/90	0.5'
Xylene	11.0	7/90	3'

**TABLE 1.3**  
**ESTIMATED QUANTITY OF TARGET CONSTITUENTS**  
**IN FORMER DRAINAGE SWALE AREA**

Constituent	Total # of Samples	Average Concen. mg/kg	Quantity in lbs (2)	Quantity in gal (3)
1,1,1-TCA	68	1.4153	4.3497	0.3625
1,1-DCA	68	0.1891	0.5812	0.0593
1,1-DCE	68	0.2263	0.6955	0.0756
Bromoform	68	0.1930	0.5932	0.0247
Methylene Chloride	68	0.5969	1.8345	0.1653
Tetrachloroethene	68	0.1095	0.3365	0.0247
Trichloroethene	68	0.0484	0.1488	0.0122
Acetone	68	2.3157	7.1171	1.0783
Ethanol	65	0.5023	1.5438	0.2339
Isopropanol	65	5.8538	17.9911	2.7679
Methyl Ethyl Ketone	20	0.4600	1.4138	0.2110
Methanol	65	4.9354	15.1685	2.2983
Benzene	78	0.0439	0.1349	0.0185
Ethylbenzene	78	0.0781	0.2400	0.0333
Toluene	78	2.3293	7.1589	0.9943
Xylene	78	1.1639	3.5771	0.4834
High BP HC (*)	65	8.4969	26.1144	3.6270
Low-Med BP HC (**)	65	290.0477	891.4326	123.8101

- (1) - calculated by dividing the sum the analytical results of all soil samples collected from within the area by the the total number of samples collected from the area. Non-detectable results are considered to be equal to the detection limit of the analyses.
- (2) - assuming volume of 1100 cubic yards at 1.4 tons/cubic yard  
= 1540 tons or 3,080,000 lbs (1,400,000 kg)
- (3) - using densities per The Merck Index, 1976
- (\*) - including results of analyses for diesel fuel
- (\*\*) - including results of analyses for kerosene, lacquer thinner and paint thinner

**TABLE 1.4**  
**ESTIMATED QUANTITY OF TARGET CONSTITUENT**  
**IN UNDERGROUND STORAGE TANK AREA**

Constituent	Total # of Samples	Average Concen. mg/kg (1)	Quantity in lbs (2)	Quantity in gal (3)
1,1-DCE	25	0.0374	0.1251	0.0136
1,1,1-TCA	25	0.0394	0.1318	0.0110
Acetone	25	0.2194	0.7337	0.1112
Isopropanol	25	0.9840	3.2905	0.4986
Methanol	25	1.4080	4.7084	0.1308
Methylene Chloride	25	0.3222	1.0774	0.0971
Toluene	25	0.0376	0.1257	0.0175

- (1) - calculated by dividing the sum the analytical results of all soil samples collected from within the area by the the total number of samples collected from the area. Non-detectable results are considered to be equal to the detection limit of the analyses.
- (2) - assuming volume of 1200 cubic yards at 1.4 tons/cubic yard  
= 1680 tons or 3,360,000 lbs (1,520,000 kg)
- (3) - using densities per The Merck Index, 1976

**TABLE 1.5**  
**ESTIMATED QUANTITY OF TARGET CONSTITUENT**  
**IN FORMER DIESEL STORAGE TANK AREA**

Constituent	Total # of Samples	Average Concen. mg/kg (1)	Quantity in lbs (2)	Quantity in gal (3)
Methylene Chloride	14	0.0643	0.0066	0.0006
Benzene	14	0.2850	0.0295	0.0040
Toluene	14	0.1371	0.0142	0.0020
Xylene	14	1.2857	0.1329	0.0180
High BP HC (*)	14	30.7857	3.1832	0.4421

- (1) - calculated by dividing the sum the analytical results of all soil samples collected from within the area by the the total number of samples collected from the area. Non-detectable results are considered to be equal to the detection limit of the analyses.
- (2) - assuming volume of 37 cubic yards at 1.4 tons/cubic yard  
= 52 tons or 104,000 lbs (47,000 kg)
- (3) - using densities per The Merck Index, 1976
- (\*) - includes results of analyses against a diesel fuel standard

**TABLE 1.6**  
**COMPARISON OF LABORATORY RESULTS**  
**OF GROUNDWATER SAMPLING (1984 to 1991)**

Target Constituent	Maximum Concentration 1984-1988		Maximum Concentration 1989		Maximum Concentration 1990		Maximum Concentration 1991	
	mg/l	Well	mg/l	Well	mg/l	Well	mg/l	Well

**A-AQUIFER**

1,1,1-TCA	2.04	V-2	1.7	V-4	0.14	V-4	0.094	V-4
1,1-DCA	2.2	V-4	7.8	V-4	0.29	V-4	0.65	V-4
1,1-DCE	0.17	V-4	0.19	V-4	0.038	V-4	0.038	V-4
1,2-DCA	2.58	V-2	nd		nd		nd	
1,3-Dichlorobenzene	0.025	V-2	nd		nd		nd	
Trans-1,2-DCE	0.012	V-3	0.2	V-3	nd		nd	
4-Nitrophenol	nd		nd		0.037	V-1	nd	
Acetone	1.2	V-2	1.7	V-4	0.1	V-4	0.033	V-8
Benzene	0.02	V-2	0.011	V-3	nd		nd	
Bromoform	0.0051	V-4	nd		nd		nd	
Carbon Tetrachloride	0.005	V-7	nd		nd		nd	
Chlorobenzene	0.037	V-2	nd		nd		nd	
Chloroethane	0.17	V-2	0.39	V-4	0.012	V-4	0.11	V-4
Chloroform	0.0007	V-7	nd		nd		nd	
Dibromochloromethane	0.0026	V-4	nd		nd		nd	
Ethanol	0.55	V-1	16	V-4	0.2	V-4	nd	
Ethylbenzene	0.012	V-2	nd		nd		nd	
High B.P. Hydrocarbons	20	V-3	33	V-3	1.1	V-1	0.62	V-4
Isopropanol	0.44	V-1	1.4	V-4	nd		nd	
Methanol	2.7	V-3	0.73	V-4	3.8	V-3	nd	
Methyl Ethyl Ketone	0.027	V-2	na		na		nd	
Methylene Chloride	142	V-2	3.5	V-4	0.053	V-3	0.15	V-4
Pentachlorophenol	0.05	V-3	nd		0.023	V-1	nd	
Phenol	0.0032	V-4	nd		nd		nd	
Tetrachloroethene	0.008	V-2	nd		nd		nd	
Toluene	0.25	V-2	nd		nd		nd	
Trichloroethene	0.019	V-2	nd		nd		nd	
Vinyl Chloride	0.016	V-4	0.0026	V-4	0.0054	V-4	0.0064	V-4
Xylene	0.08	V-2	0.003	V-3	nd		nd	

**B(1)-AQUIFER**

1,1,1-TCA	0.0068	I-2	0.0036	I-2	0.0032	I-2	0.0031	I-2
1,1-DCA	0.014	I-2	0.0046	I-2	0.003	I-2	0.0027	I-2
1,1-DCE	0.0071	I-2	0.0026	I-2	0.0022	I-2	nd	
Acetone	0.13	I-1	nd		nd		nd	
Methylene Chloride	0.032	I-1	nd		nd		nd	
Phenol	0.02	I-3	nd		0.0036	I-3	nd	
Vinyl Chloride	0.004	I-3	nd		nd		nd	

**TABLE 1.7**  
**HISTORIC FREQUENCY OF THE DETECTION OF TARGET**  
**CONSTITUENTS IN A-AQUIFER GROUNDWATER SAMPLES**  
**1984 TO 1991**

Target Constituent	Historic Frequency of Detection of Target Constituents in Groundwater Samples **												All **
	V-1	V-2	V-3	V-4	V-5	V-6	V-7	V-8	V-9	V-10	V-11	V-12	
1,1,1-TCA	1/21	12/12	6/21	34/34	0/13	4/13	20/21	13/15	1/10	1/11	0/4	0/4	92/179
1,1-DCA	15/21	11/12	16/21	34/34	0/13	0/13	21/21	1/15	10/10	0/11	0/4	0/4	108/179
1,1-DCE	2/21	5/12	3/21	33/34	0/13	0/13	17/21	1/15	0/10	0/11	0/4	0/4	61/179
1,2-DCA	0/21	2/11	1/21	3/32	0/13	0/13	0/21	0/16	0/10	0/11	0/4	0/4	6/176
1,3-Dichlorobenzene	0/2	2/11	0/19	0/10	0/3	0/3	0/3	0/2	0/1	0/2	0/0	0/0	2/56
Trans-1,2-DCE	2/21	2/11	6/21	0/30	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	10/169
4-Nitrophenol	1/19	0/3	0/18	0/20	0/9	0/9	0/8	0/4	0/4	0/4	0/0	0/0	1/97
Acetone	4/35	2/3	3/34	4/39	1/15	0/17	1/22	1/26	0/17	3/18	0/9	0/9	19/239
Benzene	0/21	2/7	1/22	0/31	0/13	1/13	0/22	0/15	0/10	0/11	0/4	0/4	4/173
Bromoform	0/20	0/11	0/21	1/31	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	1/173
Carbon Tetrachloride	0/20	0/11	0/21	0/31	0/13	0/13	1/20	0/15	0/10	0/11	0/4	0/4	1/173
Chlorobenzene	0/19	2/9	0/21	1/31	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	3/170
Chloroethane	1/20	5/11	0/21	25/31	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	31/173
Chloroform	0/20	0/11	0/21	0/31	0/13	0/13	1/21	0/15	0/10	0/11	0/4	0/4	1/173
Dibromochloro- methane	0/19	1/11	0/21	2/30	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	3/171
Ethanol	2/22	1/3	1/21	2/21	0/9	0/9	0/10	0/18	0/8	1/9	0/5	0/5	7/135
Ethylbenzene	0/20	2/6	0/21	0/28	0/13	0/13	0/20	0/15	0/10	0/10	0/4	0/4	2/164
Isopropanol	1/22	1/3	0/21	1/21	0/9	0/9	0/10	0/13	0/8	1/9	0/5	0/5	4/135
Methanol	3/22	0/3	3/21	2/21	0/9	0/9	0/10	0/13	1/8	0/9	0/5	0/5	9/135
Methyl Ethyl Ketone	1/4	3/7	0/4	0/6	0/3	0/3	0/3	0/1	0/1	0/0	0/0	0/0	7/32
Methylene Chloride	10/22	13/13	10/22	19/34	0/13	0/13	1/21	0/15	0/10	3/11	0/4	0/4	56/182
Pentachlorophenol	2/20	0/3	1/19	0/20	0/9	0/8	0/8	0/4	0/4	0/4	0/0	0/0	3/99
Phenol	0/19	0/3	0/18	1/20	0/9	0/8	0/8	0/4	0/4	0/4	0/0	0/0	1/97
Tetrachloroethene	0/20	2/11	0/21	0/30	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	2/172
Toluene	0/20	4/7	0/22	3/29	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	8/168
TPH as diesel	10/19	0/0	11/19	10/17	0/5	0/5	0/5	0/5	0/5	0/6	0/0	0/0	31/86
TPH as thinners	4/15	0/2	1/15	3/14	0/7	0/7	0/7	0/3	0/3	0/4	0/0	0/0	8/84
Trichloroethene	0/21	4/11	0/22	0/30	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	4/174
Vinyl Chloride	0/20	3/11	1/20	8/31	0/13	0/13	1/20	0/15	0/10	0/11	0/4	0/4	13/172
Xylene	0/21	5/7	2/20	0/27	0/13	0/13	0/20	0/15	0/10	0/11	0/4	0/4	7/164

\* - Ratio between number of samples in which constituent was detected at a level exceeding the analytical detection limit and the total number samples analyzed for the constituent.

\*\* - Includes results of analyses from all well locations.

**TABLE 1.8**  
**HISTORIC FREQUENCY OF THE DETECTION**  
**OF TARGET CONSTITUENTS IN**  
**B(1)-AQUIFER GROUNDWATER SAMPLES**  
**1984 TO 1991**

Target Constituent	Frequency *			All **
	I-1	I-2	I-3	
1,1,1-TCA	3/18	13/16	0/12	16/46
1,1-DCA	7/18	13/16	0/12	20/46
1,1-DCE	0/18	8/16	0/12	8/46
Acetone	3/30	1/26	0/18	4/74
Methylene Chloride	1/19	0/16	0/12	1/47
Phenol	0/7	0/6	2/12	2/25
Vinyl Chloride	0/18	0/16	1/12	1/46

\* - Ratio between number of samples in which constituent was detected at a level exceeding the analytical detection limit and the total number of samples analyzed for the constituent.

\*\* - Includes results of analyses from all well locations.



**TABLE 1.9**  
**RESULTS OF ANALYSES OF DISCHARGE WATER SAMPLES**  
**EXTRACTION WELL V-4**

Constituent	Jan 1990	Feb 1990	Feb 1990	Mar 1990	Mar 1990	Apr 1990	May 1990	June 1990	July 1990	Aug 1990	Sep 1990	Oct 1990	Nov 1990	Dec 1990
Chloroethane	nd	nd	0.015	0.012	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.036
Chloromethane	nd	nd	nd	nd	nd	nd	0.004	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	0.870	0.470	0.850	0.520	0.410	0.300	0.260	0.280	0.250	0.260	0.210	0.230	0.210	0.380
1,2-Dichloroethane	nd	nd	0.009	nd	nd	nd	0.003	nd	nd	nd	nd	nd	nd	0.003
1,1-Dichloroethene	0.085	0.048	0.060	0.040	0.048	0.033	0.022	0.035	0.036	0.035	0.023	0.022	0.013	0.033
Methylene Chloride	0.320	0.029	0.430	0.092	0.110	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	0.530	0.190	0.750	0.320	0.320	0.098	0.058	0.068	0.047	0.038	0.030	0.025	0.019	0.057
1,1,2-Trichloroethene	nd	nd	0.009	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vinyl Chloride	nd	nd	nd	0.010	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

All concentrations in mg/L

TABLE 1.10

**APPLICABLE OR RELEVANT  
AND APPROPRIATE REQUIREMENTS  
JASCO Superfund Site  
Mountain View, California**

Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
<b><u>Federal Requirements, Criteria, or Limitations</u></b>				
Safe Drinking Water Act	42 U.S.C. § 300f et seq. Pub. L 93-523	Goal of the Act is to protect human health by protecting the quality of drinking water. The Act authorizes establishment of drinking water standards.	A	Applies to CERCLA site discharges to public drinking water sources, including underground drinking water sources.
National Primary Drinking Water Standards	40 CFR Part 141	Establishes primary maximum contaminant levels (MCLs) that are health-based standards for public water systems.	R	MCLs are ARARs for any water that is considered a source or potential source of drinking water. MCLs are applicable at the tap when water is provided directly to 25 or more people or 15 or more service connections. Otherwise, MCLs are relevant and appropriate.
Maximum Contaminant Level Goals (MCLGs)	40 CFR 141, Subpart F	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	R	MCLGs are not federally enforceable drinking water standards, but CERCLA § 121(d) has raised MCLGs and water quality criteria (see below) to the level of potentially relevant and appropriate. MCLGs may be considered when a CERCLA cleanup may require more stringent standards than the MCLs. EPA has established that the use of MCLGs will be decided on a case-by-case basis. MCLGs are relevant and appropriate when the chemical-specific goal is not zero.
Clean Water Act	33 U.S.C. § 1251-1376	Provides for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. Enabling statute for a system of minimum national standards for effluent discharge; a construction grant program for POTWs; ocean discharge requirements; and water quality criteria.	A	

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water, 1976, 1980, 1986	Federal water quality criteria are guidelines from which states establish their water quality standards. Criteria are developed for the protection of human health and aquatic life.	N	Applicable to direct discharges to surface waters. An indirect discharge to a POTW may be considered an off-site activity even if the conveyance system is on site. A POTW may require a CERCLA wastewater to meet "pretreatment" standards prior to acceptance. If a water quality standard is available for a contaminant, that standard should be used rather than the criteria. Basin Plans established water quality standards in the states. Water quality criteria are relevant and appropriate when no standard exists.
National Pollutant Discharge Elimination System	40 CFR Part 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States. The Act defines a point source as any discernable, confined, or discrete conveyance from which pollutants are or may be discharged. Effluent limitations must protect beneficial uses of water.	A	Substantive requirements apply to discharges to surface water bodies or to the local storm drain system. Pretreatment standards have to be met for discharges to the POTW. Discharge to POTW will occur for this site.
National Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants that pass through or interfere with treatment processes in publicly owned treatment works (POTW) or that may contaminate sewage sludge.	A	Discharge to POTW will occur.

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Clean Air Act	42 U.S.C. §§ 7401 <u>et seq.</u>	Regulates emissions to protect human health and the environment. Enabling statute for major provisions such as National Ambient Air Quality Standards, NESHAPs, NSPS.	A	Substantive requirements of the various programs (e.g., NESHAPs, NSPS) provided by the Clean Air Act are implemented primarily through the regional Air Pollution Control Districts for stationary sources. Applicable to remedial alternatives that may result in air emissions.
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes National Ambient Air Quality Standards (NAAQS) for the protection of public health and welfare.	A	Primary standards applicable to any alternative emitting regulated pollutants.
Solid Waste Disposal Act	42 U.S.C. §§ 6901-6987	This law has been amended by RCRA and HSWA.		
Hazardous Waste Management Systems General	40 CFR Part 260	Provides definitions of hazardous waste terms, procedures for rule-making petitions, and procedures for delisting a waste.	A	Definitions may be applicable or relevant and appropriate to various potential activities. May be applicable if variances or delisting is required.
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste.	A	Applicable if the selected alternative involves generation and off-site transportation of hazardous waste.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA)	40 CFR Part 264	Establishes minimum national standards that define the acceptable management of hazardous waste for owners and operators of facilities that treat, store, or dispose of hazardous waste.	A	Any remedy that involves current treatment, storage, or disposal generally will be applicable. If the action does not involve current treatment, storage, or disposal, it may be relevant and appropriate.
General Facility Standards	40 CFR 264.10, <u>et seq.</u> Subpart B		A	Applicable to on-site treatment, storage, or disposal of hazardous waste. Location standards (i.e., setback from a Holocene fault and design, construction, operation, and maintenance

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
				standards relative to the 100-year flood) may be applicable for a new landfill.
Preparedness and Prevention	40 CFR 264.30, <u>et seq.</u> Subpart C		A	Applicable to on-site treatment, storage, or disposal of hazardous waste.
Contingency Plan and Emergency Procedures	40 CFR 264.50, <u>et seq.</u> Subpart D		A	Applicable to on-site treatment, storage, or disposal of hazardous waste.
Manifest System, Record-keeping, and Reporting	40 CFR 264.70, <u>et seq.</u> Subpart E		A	Applicable only if waste is transported for off-site treatment, storage, or disposal.
Releases from Solid Waste Management Units	40 CFR 264.90, <u>et seq.</u> Subpart F		A	Applicable if hazardous waste remains on site. The maximum contaminant concentrations that can be released from hazardous waste units are identical to the MCLs.
Closure and Post-Closure	40 CFR 264.110, <u>et seq.</u> Subpart G		A	Applicable if hazardous waste is treated or stored in a new on-site unit. Not applicable to consolidation within area of contamination or to in situ treatment.
Financial Requirements	40 CFR 264.140, <u>et seq.</u> Subpart H		A	Applicable for closure/post-closure of any treatment unit.
Use and Management of Containers	40 CFR 264.170, <u>et seq.</u> Subpart I		A	Applicable if alternative involves storage of hazardous waste in containers.
Tank Systems	40 CFR 264.190, <u>et seq.</u> Subpart J		N	Applicable if alternative involves treatment or storage of hazardous waste in tank system(s).
Surface Impoundments	40 CFR 264.220, <u>et</u>		N	No alternative is being considered that would use

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
	<u>seq.</u> , Subpart K			a surface impoundment.
Waste Piles	40 CFR 264.250, <u>et seq.</u> , Subpart L		A	Applicable if alternative involves storage of hazardous waste in waste piles for more than 90 days.
Miscellaneous Units	40 CFR 264.600, <u>et seq.</u> , Subpart X		A	Applicable if alternative involves on-site treatment in a miscellaneous unit.
Standards for the Management of Specific Hazardous Waste and Specific Types of Hazardous Waste Management Facilities	40 CFR Part 266	Establishes requirements that apply to recyclable materials that are reclaimed to recover economically significant amounts of precious metals, including gold and silver.	N	No alternative is being considered that would involve recycling or reusing hazardous waste.
Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR Part 267	Establishes minimum national standards that define acceptable management of hazardous waste for new land disposal facilities.	N	The selected alternative does not involve use of a new land disposal facility; 40 CFR Part 267 standards are not applicable.
Land Disposal Restrictions	40 CFR Part 268	Restricts the land disposal of hazardous waste and specifies treatment standards that must be met before these wastes can be land disposed.	A	Applicable if the selected alternative involves placement of waste from outside the area of contamination, if waste is removed, treated, and redeposited into the same or another unit. A treatability variance may also be applicable.
Hazardous Waste Permit Program	40 CFR Part 270	Establishes provisions covering basic EPA permitting requirements.	N	Permits are not required for on-site CERCLA response actions. Substantive requirements of 40 CFR 264 may be applicable.
Occupational Safety and Health Act	29 U.S.C. §§ 651-678	Regulates worker health and safety.	A	Applies to all response activities under the NCP. (Superseded by CAL-OSHA.)
Hazardous Material Transportation Act	49 U.S.C. §§ 1801-1813			

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Hazardous Materials Transportation Regulations	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials.	A	Applicable if waste is shipped off site.
National Historic Preservation Act	16 U.S.C. § 470 40 CFR 6.301(b) 36 CFR Part 800	Requires federal agencies to take into account the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for the National Register of Historic Places.	N	No district, site, building, structure, or object will be affected that is included in or eligible for the National Register of Historic Places.
Archaeological and Historic Preservation Act	16 U.S.C. § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	N	No historical or archaeological data will be affected.
Historic Sites, Buildings, Objects, and Antiquities	16 U.S.C. §§ 461-467 40 CFR 6.301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	N	No natural landmarks will be affected.
Fish and Wildlife Coordination Act	16 U.S.C. §§ 661-667	Requires consultation when federal department or agency proposes or authorizes any modification of any stream or other water body and requires adequate provision for protection of fish and wildlife resources.	N	
Endangered Species Act	16 U.S.C. 1531-1536 50 CFR Part 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend; includes consultation with Department of Interior.	N	The clapper rail and salt marsh harvest mouse are endangered species that inhabit tidal lands in the South Bay. However, they have not been observed on the Jasco site and are not an issue for this site.
Clean Water Act	33 U.S.C. §§ 1251- 1376			

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Dredge or Fill Requirements (Section 404)	40 CFR Parts 230, 231	Requires permits for discharge of dredged or fill material into navigable waters.	N	No activities will discharge dredged or fill materials into navigable waters of the U.S.
Protection of Navigable Waters and of Harbor and River Improvements Generally	33 U.S.C. § 403			
General Regulatory Policies - Department of the Army Corps of Engineers	33 CFR Parts 320-330	Requires permit for structures or work in or affecting navigable waters.	N	No activities will discharge dredged or fill materials into navigable waters of the U.S.
Executive Order, Protection of Wetlands	Exec. Order 11990  40 CFR §6.302(a) and Appendix A	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practical alternative exists.	N	There are no wetland impacts associated with this site.
Executive Order, Floodplain Management	Exec. Order 11988	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid adverse impacts associated with direct and indirect development of a floodplain.	N	Site not located within a flood zone.
National Wilderness Preservation System	16 U.S.C. § 1131 50 CFR § 35.1	Establishes the national system of wilderness areas, including a policy for protecting and managing these areas. It prohibits certain activities within wilderness areas.	N	There are no wilderness areas on or adjacent to the site.
National Wildlife Refuge System Administration Act	16 U.S.C. § 668dd 50 CFR § 27	Restricts activities within a National Wildlife Refuge.	N	There are no wildlife refuge areas on or adjacent to the site.
Wild and Scenic Rivers Act	16 U.S.C. § 1271 40 CFR § 6.302(e)	Prohibits adverse effects on scenic rivers.	N	There are no designated wild or scenic rivers on or adjacent to the site.

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<b><u>State Requirements, Criteria, or Limitations</u></b>				
Coastal Zone Management Act	16 U.S.C. § 1451	Governs activities in the coastal zone.	N	No activities in this operable unit will occur within the coastal zone.
Air Resources Act	Health & Safety Code, Div. 26, Sec. 39000 <u>et seq.</u>  17CCR, Part III, Chapter 1, Sec. 6000 <u>et seq.</u>	Regulates both non-vehicular and vehicular sources of air contaminants in California. Defines relationship of the California Air Resources Board (ARB) and local or regional air pollution control districts (APCDs). Establishes Ambient Air Quality Standards.	A	The Act is implemented primarily through the APCDs for stationary sources.
Bay Area Management Pollution Control District Rules and Regulations	Pollution Control District Rules and Regulations	Rules and regulations pertain to stationary sources of air emissions. Rules address prohibition of visible emissions; incinerator standards; nuisance, and compliance with PSD, NESHAPs, NSPS, and ambient air emission standards.	A	Substantive requirements applicable to alternatives that have the potential to emit air pollutants.
Air Toxics "Hot Spots" Information and Assessment Act	Health & Safety Code, Chapter 1252 Stats 1987 Sec. 44300 <u>et seq.</u>	Requires operators of facilities emitting more than a specified level of pollutants to perform an assessment of those emissions. Certain facilities, as prioritized by the air district, will need to perform a risk assessment.	A	Substantive requirements applicable to alternatives that have the potential to emit air pollutants.

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California Safe Drinking Water Act	Health & Safety Code, Div. 5, Part 1, Chapter 7, Sec. 4010 <u>et seq.</u>	Regulations governing public water systems; provides for drinking water quality standards - Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs).	R	MCLs are acceptable concentration limits from a "free flowing cold water outlet of the ultimate user." To apply this standard as a cleanup level for groundwater means that the law, and the standard, is "relevant and appropriate."
	22 CCR, Div. 4, Chapter 15, Sec. 64401 <u>et seq.</u>	Establishes primary and secondary drinking water standards for public water systems.		
Porter Cologne Water Quality Control Act	Water Code, Div. 7, Sec. 13000 <u>et seq.</u>	Identifies general duties and authorities of state and regional water boards, including preparation of a Basin Plan and enforcement of water quality regulations.	A	The San Francisco Bay Regional Water Quality Control Board would be involved in setting cleanup goals for contaminated soil and groundwater. The Region Basin Plan includes limitations on surface water discharges. It adopts State Board Resolutions 68-16, which applies to maintaining water quality; and 88-63, which sets criteria for groundwater to be considered a drinking water source; and Regional Board Resolution 88-160, which applies to disposal of extracted groundwater from groundwater remediation projects.
	<u>23 CCR, Div. 3:</u>			
	- Chapter 9, Sec. 2200 <u>et seq.</u>	Waste Discharge Reports and Requirements.	A	
	- Chapter 9.1, Sec. 2240 <u>et seq.</u>	Enforcement Procedures for Cease and Desist Orders.	N	
	- Chapter 10, Sec. 2300 <u>et seq.</u>	Licensing and Regulation of Use of Oil Spill Cleanup Agents	N	Oil spill cleanup agents are not part of potential alternatives.

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
	- Chapter 15, Sec. 2510 <u>et seq.</u>	Discharge of Waste to Land. Regulations establishing waste and site classifications and waste management requirements for waste treatment, storage, or disposal in landfills, surface impoundments, waste piles, and land treatment facilities.	N	Substantive requirements may be applicable or relevant and appropriate if alternative involves use of new landfill. No alternatives involve the use of new landfills. Exempt pursuant to 23 CCR Section 2511 (d).
	- Chapter 16, Sec. 2610 <u>et seq.</u>	Underground Tank Regulations. New and existing UST construction, monitoring, repairs, releases of substances, and closure.	A	There are underground tanks that will be removed in the future and remediation of that area will occur.
Water Well Standards, State of California	Bulletin 74-81	The standards are intended to apply to the construction and major reconstruction or destruction of water wells.	A	Well construction, abandonment, and destruction will comply with these standards.
California Hazardous Waste Control Laws	Health & Safety Code, Div. 20, Chapter 65, Sec. 25100, <u>et seq.</u>	Regulations governing hazardous waste control; management and control of hazardous waste facilities; transportation; laboratories; classification of extremely hazardous, hazardous, and nonhazardous waste.	A	
	22 CCR, Div. 4 Chapter 30, Sec. 66001 <u>et seq.</u>	Minimum standards for management of hazardous and extremely hazardous waste.	A	
Safe Drinking Water & Toxics Enforcement Act of 1986 ("Proposition 65")	Health & Safety Code, Div. 20, Chapter 6.6, Sec. 25249.5 <u>et seq.</u>	Provides protection of drinking water by prohibiting any detectable discharge of certain listed carcinogens and reproductive toxicants. Requires warnings to be given when any exposure to the chemicals (regulated under the Act) is anticipated.	N	Provisions apply only to certain listed chemicals and to persons in the course of doing business.

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California Hazardous Substance Account Act/Hazardous Substances Cleanup Bond Act	Health & Safety Code, Div. 20, Chapter 6.8, Sec. 25300 <u>et seq.</u>	Establishes a program to provide for response authority for releases of hazardous substances; compensation for injuries resulting from exposure to release of hazardous substances; and adequate matching funds for CERCLA actions.	N	Not an ARAR.
Hazardous Materials Release Plans and Inventory Requirements	Health & Safety Code, Div. 20, Chapter 6.95, Sec. 25500 <u>et seq.</u>  19 CCR, Chapter 2, Subchapter 3, Sec. 2620 <u>et seq.</u>	Reporting requirements for a release or threatened release of a hazardous material. Sets requirements for "Area Plans"; "Business Plans"; the Acutely Hazardous Materials Registration form; and the Risk Management and Prevention Program.	N	Not an ARAR for CERCLA activities.
Environmental Quality Assessment Requirements	Health & Safety Code, Div. 20, Chapter 6.98, Sec. 25570 <u>et seq.</u>	Requirements and procedures for preparation of environmental quality assessments (environmental audits).	N	Not an ARAR for CERCLA activities.
Hazardous Substances Act	Health & Safety Code, Div. 22, Chapter 13, Sec. 28740 <u>et seq.</u>	Provides definitions of "hazardous substance" and "toxic."	A	Applicable to hazardous substances identified in the code.
California Environmental Quality Act (CEQA)	Pub.Res. Code, Div. 13  14 CCR, Div. 6, Sec. 15000 <u>et seq.</u>	Provides for the environmental review of discretionary actions.  Guidelines for implementation of CEQA, including responsibilities of public agencies, lead agencies, initial studies, negative declaration declaration process, EIR process, time limits, contents, review, and approval.	N	
Fish and Game Regulations on Pollution	Fish and Game Code, Div. 6, Part 1,	Codifies the prohibition of water pollution with any substance or material deleterious to fish,	N	

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
	Chapter 2, Sec. 5650 <u>et seq.</u>	plant life, or bird life.		
California Highway Patrol Hazardous Material	Cal. Vehicle Code § 32000 <u>et seq.</u> ; 13 CCR § 1160 <u>et seq.</u>		A	May be applicable to transportation of hazardous materials from the site.
Hazardous Waste Movement Committee Memorandum of Understanding	An agreement made on November 8, 1983, by the DHS, Caltrans, and CHP	An agreement between the Departments of Health Services, Transportation (Caltrans), and California Highway Patrol to coordinate with each other for the transportation of large quantities of hazardous wastes excavated from abandoned sites.	N	If selected alternative involves off-site transport of large quantities of hazardous waste, may have to be complied with. Not an ARAR because it applies to off-site activities.
California Occupational Health and Safety Act	Labor Code, Div. 5, Sec. 6300 <u>et seq.</u>	Regulations to assure safe and healthy working conditions by authorizing the enforcement of standards and procedures.	A	Worker health and safety is regulated primarily by CAI-OSHA, which generally supercedes federal OSHA.
	8 CCR, Chapter 4: Subchapter 4, Sec. 1500 <u>et seq.</u>	A detailed analysis of construction safety regulations.		
	Subchapter 5, Sec. 2300 <u>et seq.</u>	A detailed analysis of electrical safety regulations.		
	Subchapter 7, Sec. 3200 <u>et seq.</u>	A detailed analysis of general industrial safety regulations, including procedures, equipment, and structures.		
Criteria for Identification of Hazardous and Extremely Hazardous Wastes Threshold	22 CCR, Div. 4, Chapter 30, Art. 11, Sec. 66693-66747	Promulgated criteria to evaluate whether a material is hazardous. Includes Soluble Threshold Limit Concentration (STLC) and	A	STCL and TTLC chemical-specific values reflect the chemical characteristics of persistence and bioaccumulation. The limits are not health-

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Statute or Regulation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Limit Concentrations		Total Threshold Limit Concentration (TTLC).		based.
Water Quality Objectives	RWQCB Criteria	Promulgated criteria setting chemical-specific concentration levels for a variety of uses of specific bodies of water. Based on the beneficial uses of specified water bodies.	N	Regional Water Quality Control Objectives are identified in the Water Quality Control Plan Reports (Basin Plans) of the nine Regional Water Quality Control Boards.
Underground Storage of Hazardous Substances Requirements	Health & Safety Code, Div. 20, Chapter 6.7, Sec. 25280 <u>et seq.</u>	Regulations governing the testing, monitoring, and replacing of underground storage tanks.	A	Underground tanks will be removed in the future and the area remediated. No tanks will be installed.
California Coastal Act of 1976	Pub. Res. Code, Div. 20, Sec. 30000 <u>et seq.</u>	Governs activities in the coastal zone.	N	No activities will be performed in the coastal zone in this operable unit.
McAteer-Petris Act of 1969 (BCDC)	Title 14 Administrative Code, Sec. 66600 <u>et seq.</u>	Provides permit authority over any construction within 100 feet of tidal waters of San Francisco Bay and in tidal waters.	N	No construction within 100 feet of tidal waters.
<u>Federal and State Criteria, Advisories, and Guidance to be considered</u>				
National Secondary Drinking Water Standards	40 CFR Part 143	Secondary maximum contaminant levels (SMCLs). Standard to control chemicals in drinking water that primarily affects the aesthetic qualities relating to public acceptance of drinking water.		Secondary standards are not federally enforceable; intended as guidelines for the states. SMCLs are not ARARs unless promulgated by state.
National Maximum Contaminant Level Goals	Pub. L. 99-339, 100 Stat. 642 (1986)	Establishes drinking water quality goals (MCLGs), at levels of no known or anticipated adverse health effects with an adequate margin of safety. MCLGs do not take cost or feasibility into account. Under SDWA, MCLGs are goals, not enforceable standards.		

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Water Quality Standards	40 CFR Part 131	Nonenforceable criteria for water quality to protect human health and aquatic life. From the water quality criteria, states adopt water quality standards that protect a designated use. A water quality standard defines the water quality goals of a water body through use of designations and criteria to protect the designated uses.		CERCLA requires that the remedy selected must require a level or standard of control that at least attains water quality criteria established under Section 304 or 303 of the Clean Water Act. CERCLA also states "in determining whether or not any water quality criteria...is relevant and appropriate...the President shall consider the designated or potential use of the surface or ground water, the environmental media affected, the purposes for which the criteria were developed, and the latest information available."
Media Cleanup Standards (MCSs) (proposed)	55 FR 30798 Sec. 264.525	Proposed amendment to RCRA regulations. MCSs are established at concentrations that ensure protection of human health and the environment. Standards are set for each medium during the remedy selection process.		The regulations are proposed and therefore TBCs. When promulgated, the standards are potential ARARs.
<b><u>Other Potential Federal and State Criteria, Advisories, and Guidance to be Considered</u></b>				
Health Advisories	EPA and National Academy of Sciences	Health advisories developed for short-term, long-term, and lifetime exposures. The advisories are considered to be guidance and are not enforceable.		
Corrective Action for Solid Waste Management at Hazardous Waste Management Facilities	40 CFR 264.500 - 264.560, Subpart S (proposed)	Proposed rule establishes procedures and technical requirements for implementing corrective action under Section 3004(u) of RCRA. The regulations define requirements for conducting remedial investigations, evaluating potential remedies, and selecting and implementing remedies at RCRA facilities.		Provisions of the proposed rule (e.g., media cleanup standards, conditional remedies) must be addressed as TBCs.
Site-Specific Health-Based Goals	(PRC, 1992)	Conservative concentration standards for carcinogens and non-carcinogens in soil.		

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**TABLE 1.11**  
**STANDARDS, PROPOSED STANDARDS AND ACTION LEVELS**  
**DRINKING WATER SOURCES**  
**CALIFORNIA AND FEDERAL REGULATIONS**

Constituent	STATE		FEDERAL				
	MCL	AAL	MCL	Proposed	Proposed	MCLG	Proposed
	(1)	(2)		MCL	SMCL		MCLG
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Benzene	0.001	0.0002	0.005	-	-	-	-
Carbon Tetrachloride	0.0005	-	0.005	-	-	-	-
Chloroform	-	0.006	-	-	-	-	-
1,1-Dichloroethane	0.005	-	-	-	-	-	-
1,2-Dichloroethane	0.0005	-	0.005	-	-	-	-
1,1-Dichloroethylene	0.006	-	0.007	-	-	-	-
Ethylbenzene	0.68	2.0	0.7	-	0.30	0.7	-
Methyl Ethyl Ketone	-	2.0	-	-	-	-	-
Methylene Chloride	-	-	-	0.005	-	-	-
Pentachlorophenol	-	0.002	-	0.001	0.03	-	0.0
Tetrachloroethylene	0.005	-	0.005	-	-	0.0	-
Toluene	-	2.0	1.0	-	0.04	1.0	-
1,1,1-Trichloroethane	0.2	0.3	0.2	-	-	-	-
Trichloroethylene	0.005	0.007	0.005	-	-	-	-
Vinyl Chloride	0.0005	0.0005	0.002	-	-	-	-
Xylenes	1.75	2.0	10.0	-	0.02	10.0	-

- (1) Maximum Contaminant Level for Primary Drinking Water Sources (22 CCR 644)  
(2) Applied Action Levels for risk appraisal, California Dept. of Health Services, 1989  
(3) Maximum Contaminant Level - Safe Drinking Water Act (42 U.S.C. Pub. L. 93-523)  
(4) Proposed Secondary Maximum Contaminant Level - Safe Drinking Water Act (42 U.S.C. Pub. L. 93-52  
Safe Drinking Water Act (42 U.S.C. Pub. L. 93-523)  
(5) Maximum Contaminant Level Goal (40 CFR 141, Subpart F)



**TABLE 2.1**  
**SOIL REMEDIATION STANDARDS**  
**FOR TARGET CONSTITUENTS WITH A**  
**COMPARISON TO MEASURED CONCENTRATIONS**

CONSTITUENT	SELECTED CLEANUP STANDARD (mg/kg)	MAX. CONC. IN SITE SOIL AFTER INTERIM REMEDATION (*) (mg/kg)	MAX. CONC. IN SITE SOIL PRIOR TO INTERIM REMEDATION (*) (mg/kg)
1,1-Dichloroethane (1,1-DCA)	0.6	3	34
1,1-Dichloroethene (1,1-DCE)	2	1.7	13
1,2-Dichloroethane (1,2-DCA)	0.03	nd	3.9
1,2-Dichloroethene (1,2-DCE)	1	0.015	0.015
1,1,1-Trichloroethane (1,1,1-TCA)	100	61	61
Acetone	30	100	270
Benzene	0.3	3	3
Chloroethane	4,000	nd	nd
Diesel or Kerosene Mixture	10,000	6,700	11,000
Ethylbenzene	3,000	1.2	170
Methanol	200	60	60
Methyl Ethyl Ketone	9	na	na
Methylene Chloride	0.2	21	3,400
Pentachlorophenol	200	nd	0.2
Tetrachloroethene (PCE)	7	4	16
Toluene	3	110	1,700
Trichloroethene (TCE)	3	0.05	0.05
Vinyl Chloride	0.02	nd	nd
Xylene	2,000	37	210

(\*) - Interim remediation consisted of the excavation and disposal of approximately 572 cubic yards of the soil containing the highest concentrations of target constituents. This work was completed in 1988.

**TABLE 2.2**  
**GROUNDWATER REMEDIATION STANDARDS**  
**FOR TARGET CONSTITUENTS WITH A**  
**COMPARISON TO MEASURED CONCENTRATIONS**

CONSTITUENT	SELECTED CLEANUP STANDARD (*) (mg/kg)	MAX. CONC. IN SITE GROUNDWATER JANUARY, 1992 (mg/kg)	MAX. CONC. IN SITE GROUNDWATER 1991 (mg/kg)
1,1-Dichloroethane (1,1-DCA)	0.005	0.61	0.65
1,1-Dichloroethene (1,1-DCE)	0.006	0.058	0.038
1,2-Dichloroethane (1,2-DCA)	0.0005	<0.005	<0.005
1,2-Dichloroethene (1,2-DCE)	0.006	<0.005	<0.005
1,1,1-Trichloroethane (1,1,1-TCA)	0.2	0.094	0.094
Acetone	4	<0.01	<0.05
Benzene	0.001	<0.005	<0.005
Chloroethane	30	0.043	0.023
Diesel or Kerosene Mixture	3	0.63	0.62
Ethylbenzene	0.68	<0.005	<0.005
Methanol	20	<0.06	<0.06
Methyl Ethyl Ketone	0.6	na	na
Methylene Chloride	0.005	<0.005	0.15
Pentachlorophenol	0.001	<0.01	<0.01
Tetrachloroethene (PCE)	0.005	<0.005	<0.005
Toluene	1	<0.005	<0.005
Trichloroethene (TCE)	0.005	<0.005	<0.005
Vinyl Chloride	0.0005	0.017	0.0064
Xylene	1.75	<0.005	<0.005

(\*) - Groundwater cleanup standard is equal to the maximum contaminant level as set or proposed by Federal or State standards, whichever is more stringent, or in the absence of an established or proposed MCL the standard is equal to the Site-specific Health-Based Standard for Groundwater as calculated by PRC (1992).

**TABLE 2.3**  
**GENERAL RESPONSE ACTIONS FOR SOIL AND GROUNDWATER**

<b><u>GENERAL SCREENING ACTIONS</u></b>	<b><u>MEDIA</u></b>	<b><u>DESCRIPTIONS</u></b>	<b><u>COMMENTS</u></b>	<b><u>STATUS</u></b>
<b>No Action</b>	Ground Water	No action; groundwater extraction and discharge would be stopped	Mandatory consideration per EPA guidance document	Retained
	Soil	No action per EPA guidance document	Mandatory consideration	Retained
<b>Institutional Actions</b>	Ground Water	Restrictions applied pertaining to site usage; use of alternate	Potentially applicable to protect potential receptors water supplies	Retained
	Soil	Land use restrictions protect potential receptors	Potentially applicable to	Retained
<b>Collection</b>	Ground Water	Extraction of ground water prior to treatment and/or disposal treatment	Potentially applicable; currently in use at the site without additional	Retained
	Soil	Extraction of soil vapors prior to treatment and/or disposal	Potentially applicable	Retained
<b>Containment</b>	Ground Water	The impediment of ground water flow to control the migration of contaminants	Potentially applicable in retarding down-gradient flow	Retained
	Soil	The encapsulation of contaminated media to control the migration of contaminants	Potentially applicable to minimizing migration of contaminants	Retained
<b>Diversion</b>	Ground Water	The deflection of ground water flow away from areas of contamination for preventing down-gradient flow	Not effective for remediation of shallow A-zone groundwater or	Not applicable
<b>Excavation</b>	Ground Water	Partial excavation and recovery of identified contamination established by the regulatory agencies	Alone, may not achieve remediation goals for groundwater	Not applicable
<b>Excavation</b>	Soil	Partial excavation and recovery of identified source area contaminated soil	Potentially effective by removing heavily	Retained

**TABLE 2.3**  
**GENERAL RESPONSE ACTIONS FOR SOIL AND GROUNDWATER**

<b><u>GENERAL SCREENING ACTIONS</u></b>	<b><u>MEDIA</u></b>	<b><u>DESCRIPTIONS</u></b>	<b><u>COMMENTS</u></b>	<b><u>STATUS</u></b>
<b>On-Site Treatment</b>	Ground Water	Biological, physical, and/or chemical treatment applied to contaminated groundwater groundwater	Potentially effective in reducing concentrations of organics present in the groundwater	Retained
	Soil	Biological, physical, thermal, and/or chemical treatment applied to contaminated soil soil	Potentially effective in reducing concentrations of organics present in the soil	Retained
<b>In-situ Treatment</b>	Ground Water	Biological treatment applied to contaminated groundwater while still in place	Potentially effective in reducing organics concentrations	Retained
	Soil	Biological, physical, thermal treatment and/or vitrification applied to contaminated soil while still in place	Potentially effective in reducing organics concentrations	Retained
<b>Off-Site Discharge</b>	Ground Water	Extracted ground water discharged to local POTW of organics	Potentially effective in reducing concentrations of organics	Retained
	Soil	Excavated soil treated and/or disposed of at RCRA facility; disposal at RCRA facility is discouraged by SARA (1986)	Potentially effective in reducing concentrations of organics	Retained
<b>On-Site Discharge</b>	Ground Water	Extracted ground water treated and discharged on-site via NPDES permit or injection wells	Potentially effective in reducing concentrations of organics; discharge via NPDES permit needed	Retained
<b>Relocation</b>	Ground Water and Soil	Reimbursement of buildings and land costs impacted by organics contaminated ground water and soil to public receptors; includes relocation costs	No complete exposure pathways present at the site	Not applicable

Table 2.4: Initial Screening of Technologies and Process Options for Groundwater

<u>General Response Actions</u>	<u>Remedial Technology</u>	<u>Process Options</u>	<u>Description</u>	<u>Screening Comments</u>
No Action	None	Not applicable	No action	Required for consideration
Institutional Actions	Access restrictions	Deed restrictions	Deeds for property would include restrictions on wells	Potentially applicable
	Alternate water supply	City water supply	Connect affected residents to municipal water system	Not applicable, residents now served by municipal water system
	Monitoring	Ground water monitoring	On-going monitoring of wells	Potentially applicable
Collection	Extraction	Ground water recovery	Series of wells to extract contaminated ground water	Potentially applicable, one well already in place
Containment	Cap	Clay and soil cap	Compacted clay covered with soil over areas of contamination	Potentially applicable
	Vertical barrier	Slurry wall	Trench around contaminated area is filled with a soil (or cement) bentonite slurry	Potentially applicable
	Vertical barrier	Grout curtain	Pressure injection of grout in a ground through boreholes	Potentially applicable
	Horizontal barrier	Grout injection	Pressure injection of grout at depth	Not applicable, will not stop lateral migration of contaminants
On-site Treatment	Biological Treatment	Aerobic	Biological degradation of organic contaminants using microorganisms in an aerobic environment in a bioreactor	Potentially applicable
	Biological Treatment	Anaerobic	Biological degradation of organic contaminants using microorganisms in an anaerobic environment in a bioreactor	Potentially applicable
	Physical Treatment	Carbon Adsorption	Adsorption of contaminants onto activated carbon	Potentially applicable
	Physical Treatment	Resin Adsorption	Adsorption of contaminants onto synthetic adsorbents	Potentially applicable
	Physical Treatment	Coagulation/ Flocculation	Fine suspended particulates are formed into larger settleable particles	Not applicable, no suspended contaminants
	Physical Treatment	Steam Stripping	Organics are removed by contact with steam and recovery of vapors	Potentially applicable

Table 2.4: Initial Screening of Technologies and Process Options for Groundwater

<u>General Response Actions</u>	<u>Remedial Technology</u>	<u>Process Options</u>	<u>Description</u>	<u>Screening Comments</u>
On-site Treatment	Physical Treatment	Filtration	Suspended contaminants are trapped as influent is forced through a filter media	Not applicable, no suspended contaminants
	Physical Treatment	Reverse Osmosis	Separation of contaminants via application of pressure gradient across a semi-permeable membrane	Not applicable for low molecular weight VOCs present at Jasco
	Physical Treatment	Air Stripping	Transfer of VOCs from aqueous stream into a gas stream	Potentially applicable
	Chemical Treatment	Dechlorination	Reaction to remove chlorine atom(s) from chlorinated VOCs to form alkali metal salt and a substituted organic polymer	Not applicable for chlorinated compounds on-site
	Chemical Treatment	Neutralization	Chemical adjustment of pH	Not applicable for VOCs
	Chemical Treatment	Solvent extraction	Contaminants are extracted by contacting it with another immiscible liquid, usually a solvent	Not appropriate for dilute mixture of contaminants
	Chemical Treatment	UV Peroxidation	Chemical bonds are broken to form CO <sub>2</sub> and H <sub>2</sub> O using ultra-violet light and a strong oxidizer such as ozone or H <sub>2</sub> O <sub>2</sub>	Potentially applicable
	Chemical Treatment	Supercritical water oxidation	The properties of supercritical water bring about rapid oxidation of organics and precipitation of inorganics	Potentially applicable
In-situ Treatment	Biological Treatment	Aerobic	Injection of nutrients and/or microorganisms to enhance biological degradation	Potentially applicable
	Biological Treatment	Anaerobic	Biological degradation of contaminants in an anaerobic environment	Potentially applicable
Discharge	Off-site discharge	POTW	Extracted ground water is discharged to local POTW for treatment	Potentially applicable
	On-site discharge	NPDES	Groundwater is treated and discharged to storm sewer	Potentially applicable
	On-site discharge	Injection wells	Re-inject treated water into water bearing zone	Not applicable

Table 2.5: Initial Screening of Technologies and Process Options for Soil

<u>General Response Actions</u>	<u>Remedial Technology</u>	<u>Process Option</u>	<u>Description</u>	<u>Screening Comments</u>
No Action	None	Not applicable	No action	Required for consideration
Institutional Actions	Access restrictions	Deed restrictions	Deeds for property would include restrictions on soil usage	Potentially applicable
	Monitoring	Vadose monitoring	Monitoring of vadose zone soil gases	Potentially applicable
Collection	Extraction	Vapor extraction	Series of wells to extract contaminated soil vapor	Potentially applicable
Containment	Cap	Asphalt cap	Capping soil with asphaltic concrete	Potentially applicable
	Liner	Clay liner	Treating soil to an appropriate level and then replacing in a lined area to reduce leachate potential	Potentially applicable
Excavation	Excavation and Underground Tank Removal	Physically removing source area	Defined areas of contaminated soil and other potential sources, such as tanks, excavated	Potentially applicable
On-site Treatment	Biological Treatment	Aerobic	Aerobic biological degradation of organic compounds using microorganisms in a bioreactor	Potentially applicable
		Enhanced Aerobic Biological Treatment	Aerobic biological treatment with aeration provided by vapor extraction	Potentially applicable
		Anaerobic	Anaerobic biological degradation of organic compounds using microorganisms in a bioreactor	Potentially applicable
	Physical Treatment	Soil Washing	Extraction of contaminants by washing soil with an appropriate solvent	Potentially applicable
	Physical Treatment	Carbon Adsorption	Adsorption of contaminants onto activated carbon	Not applicable; method is used for water treatment
	Physical Treatment	Resin Adsorption	Adsorption of contaminants onto synthetic adsorbents	Not applicable; method is used for water treatment
	Physical Treatment	Desorption	Contaminants separated by heating soil	Potentially applicable
	Physical Treatment	Heated stripping	Transfer of VOCs from soil into a hot gas stream	Potentially applicable

Table 2.5: Initial Screening of Technologies and Process Options for Soil

<u>General Response Actions</u>	<u>Remedial Technology</u>	<u>Process Option</u>	<u>Description</u>	<u>Screening Comments</u>
On-site Treatment	Chemical Treatment	Dechlorination	Reaction to remove chlorine atom(s) from chlorinated VOCs to form alkali metal salt and a substituted organic polymer	Not applicable for contaminants at Jasco, process designed for PCBs and dioxins.
	Chemical Treatment	Neutralization	Chemical adjustment of pH	Not applicable for VOCs
	Thermal Treatment	Incineration	Contaminated soil are exposed to extreme heat to destroy the contaminants	Not applicable; an incinerator would not acceptable to the local citizens or government
In-situ Treatment	Biological Treatment	Aerobic	Injection of nutrients and/or microorganisms into media to enhance biological degradation in place	Potentially applicable
	Solidification	Vitrification	Soil is melted at extremely high temperatures to form glass; contaminants are destroyed and/or immobilized within the glass matrix	Potentially applicable
Discharge	Off-site discharge	RCRA Facility	Contaminated soil transported to RCRA facility for treatment and disposal	Potentially applicable



Table 2.6: Selection of Representative Groundwater Remedial Options

<b>General Response Actions</b>	<b>Remedial Technology</b>	<b>Process Options</b>	<b>Effectiveness</b>	<b>Implementability</b>	<b>Cost</b>	<b>Retained for Remedial Alternatives</b>
No Action	None	Not applicable	Will not achieve remedial action objectives	Implementable, not acceptable to public or local government	None	Yes
Institutional Actions	Access restrictions	Deed restrictions	Effectiveness depends on future enforcement of restrictions	Implementable, legal requirements	Low capital	Yes
	Monitoring	Ground water monitoring	Effective in determining migration of contaminants	Implementable, already in place	Low to moderate capital, high O&M	Yes
Collection	Extraction	Ground water extraction	Effective, may need to be treated prior to discharge	Implementable, already in place with no other treatment	Low to moderate capital, moderate O&M	Yes
Containment	Cap	Clay and Soil Cap	Not effective for remediation; can be used to prevent further contamination prior to remedial action	Implementable	Low to moderate capital, low to moderate O&M	No
	Vertical Barrier	Slurry Wall	Limited effectiveness, long-term effectiveness not proven	Difficult to implement, must be tied to aquitard	Extremely high capital, low O&M	No
	Vertical Barrier	Grout Curtain	Limited effectiveness, long-term effectiveness not proven	Difficult to implement, must be tied to aquitard	Extremely high capital, low O&M	No
On-site Treatment	Biological Treatment	Aerobic	Effectiveness to be determined for chlorinated compounds	Implementability to be determined	Low to moderate capital, moderate O&M	Yes
	Biological Treatment	Anaerobic	Effective for select chlorinated compounds. Used in line with aerobic treatment	Implementability to be determined	Low to moderate capital, low to moderate O&M	Yes

Table 2.6: Selection of Representative Groundwater Remedial Options

<b>General Response Actions</b>	<b>Remedial Technology</b>	<b>Process Options</b>	<b>Effectiveness</b>	<b>Implementability</b>	<b>Cost</b>	<b>Retained for Remedial Alternatives</b>
<b>On-site Treatment</b>	Physical Treatment	Carbon Adsorption	Effective in reducing concentration of contaminants	Implementable	Moderate capital, moderate O&M	Yes
	Physical Treatment	Resin Adsorption	Effective in reducing concentration of contaminants	Implementable	Moderate capital, moderate O&M	No
	Physical Treatment	Steam Stripping	Effective in reducing concentration of contaminants	Implementable	Moderate capital, high O&M	No
	Physical Treatment	Air Stripping	Effective in reducing concentrations of contaminants. Air may need to be treated.	Implementable	Moderate capital, moderate O&M	Yes
	Chemical Treatment	UV Peroxidation	Effective in destroying contaminants	Implementable	Low to moderate capital, low to moderate O&M	Yes
	Chemical/Physical Treatment	Supercritical water oxidation	Effective in destroying organic compounds	Implementable	High capital, high O&M	No
<b>In situ Treatment</b>	Biological	Aerobic	To be determined	To be determined	To be determined	Yes
	Biological	Anaerobic	To be determined	To be determined	To be determined	Yes
<b>Discharge</b>	Off-site discharge	POTW	Effective in removing contaminated ground water from the aquifer. Treatment is left to city sewage treatment facility.	Implementable, already in place. Concentrations of contaminants must be monitored and remain below permitted level.	Low to moderate capital, low O&M	Yes
	On-site discharge	NPDES	Effective in removing contaminated ground water from the aquifer.	Implementable, permit required.	Moderate to high for laboratory analysis	No

Table 2.7: Selection of Representative Soil Remedial Options

<b>General Response Actions</b>	<b>Remedial Technology</b>	<b>Process Option</b>	<b>Effectiveness</b>	<b>Implementability</b>	<b>Cost</b>	<b>Retained for Remedial Alternatives</b>
No Action	None	Not applicable	Does not achieve remedial action objectives	Not acceptable to public or government	None	Yes
Institutional Actions	Access restrictions	Deed restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination	Legal requirements and authority	Negligible cost	Yes
	Monitoring	Vadose monitoring	Useful for documenting conditions. Does not reduce contamination.	Alone, not acceptable to public or government	Low capital, low O&M	Yes
Collection	Extraction	Vapor extraction	Effective for VOC's; not effective for non- and semi-volatile	Implementable	Low to moderate capital, moderate O&M	Yes
Containment	Cap	Asphalt cap	Effective, but susceptible to cracking	Implementable	Low to moderate capital, high O&M	Yes
	Liner	Clay liner	Effective, but susceptible to cracking	Implementable	Low to moderate capital, moderate O&M	Yes
Excavation	Excavation	Excavate known areas of contamination	Effective in removing contamination sources	Implementable	Moderate to high capital, no O&M	Yes

Table 2.7: Selection of Representative Soil Remedial Options

<b>General Response Actions</b>	<b>Remedial Technology</b>	<b>Process Option</b>	<b>Effectiveness</b>	<b>Implementability</b>	<b>Cost</b>	<b>Retained for Remedial Alternatives</b>
<b>On-site Treatment</b>	<b>Biological Treatment</b>	Aerobic	Effectiveness to be determined for chlorinated VOCs	Implementable	Low to moderate capital, low O&M	No
		Enhanced aerobic biological treatment	Effectiveness to be determined for chlorinated VOCs	Implementable	Low to moderate capital, low O&M	Yes
		Anaerobic	Effectiveness to be determined for chlorinated VOCs	Implementable	Low to moderate capital, low O&M	Yes
<b>On-site Treatment</b>	<b>Physical Treatment</b>	Excalibur Soil Washing Process	Effectiveness needs to be evaluated in treatability study	Implementable	To be determined	Yes
	<b>Physical Treatment</b>	Desorption	Effective for VOCs; less effective for non- and semi-volatiles	Implementable	High capital, high O&M	No
	<b>Physical Treatment</b>	Heated Stripping	Effective in reducing concentration of contaminants	Implementable	Moderate to high capital; moderate to high O&M	No
<b>In situ Treatment</b>	<b>Biological</b>	Aerobic	To be determined	To be determined	To be determined	Yes
	<b>Biological</b>	Anaerobic	To be determined	To be determined	To be determined	Yes
	<b>Solidification</b>	Vitrification	Effective in thermally destroying or immobilizing contaminants	Not implementable; possibility in damaging nearby railroad tracks	High capital	No
<b>Discharge</b>	<b>Off-site discharge</b>	RCRA Facility	Effective for disposal of hazardous waste	Implementable, Jasco still liable for future liability	High capital	Yes

TABLE 2.8  
ANALYTICAL REQUIREMENTS  
UNDER NPDES PERMIT

<u>Analysis</u>	<u>Frequency</u>	<u>Estimated Cost per Sample</u>
96-hour Bioassay	Biannually	\$600
Metals (As,Ag,Cr,C Cu, Hg, Ni, Pb Se, Zn)	Monthly	\$225
EPA Method 601/60	Monthly	\$125
EPA Method 8015	Monthly	\$200
EPA Method 625	Biannually	\$500

**TABLE 3.1 EVALUATION OF FINAL GROUNDWATER ALTERNATIVES**

<b>Criteria</b>	<b>Alternative I <u>No Action</u></b>	<b>Alternative II <u>Discharge to POTW</u></b>	<b>Alternative III <u>UV Oxidation</u></b>	<b>Alternative IV <u>Carbon Adsorption</u></b>	<b>Alternative V <u>Air Stripping</u></b>	<b>Alternative VI <u>Biological Treatment w/Carbon Adsorption</u></b>
<b><u>OVERALL PROTECTIVENESS</u></b>						
Human Health Protection - Groundwater Ingestion	No current groundwater users, no reduction for future users.	No existing users of groundwater, will reduce risk for future users.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
Environmental Protection	Allows continued contamination of groundwater.	Continued contamination is curbed by capturing plumes of contamination; will provide treatment for current contamination.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
<b><u>COMPLIANCE WITH ARARs</u></b>						
- Chemical Specific ARARs	Does not comply with ARARs.	Treated water will comply with ARARs; groundwater within aquifer will undergo treatment until compliance to ARARs is achieved.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
<b><u>LONG-TERM EFFECTIVENESS AND PERMANENCE</u></b>						
Magnitude of Residual Risk - Groundwater Ingestion	Future risk may increase as contaminants migrate further.	Future risk will be reduced as contaminated groundwater is treated.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
Adequacy and Reliability of Controls	No controls over remaining contamination.  No reliability.	Extraction wells will be designed to control migration of groundwater plume.  Reliable, this system has in use since 1987.	See Alternative II.  Process is relatively simple, but equipment problems will have to be serviced by vendor.	See Alternative II.  Reliable process. Effluent needs to be monitored for breakthrough.	See Alternative II.  Reliable process. Air and water effluent will need to be monitored for breakthrough.	See Alternative II.  May need treatability study to optimize process.
Need for 5-year Review	Should be reviewed to ensure adequate protection of human health and environment	See Alternative I. Also recommended to justify continued treatment.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.

**TABLE 3.1 EVALUATION OF FINAL GROUNDWATER ALTERNATIVES**

<b>Criteria</b>	<b>Alternative I <u>No Action</u></b>	<b>Alternative II <u>Discharge to POTW</u></b>	<b>Alternative III <u>UV Oxidation</u></b>	<b>Alternative IV <u>Carbon Adsorption</u></b>	<b>Alternative V <u>Air Stripping</u></b>	<b>Alternative VI <u>Biological Treatment w/Carbon Adsorption</u></b>
<b><u>REDUCTION OF TOXICITY, MOBILITY, AND/OR VOLUME</u></b>						
<b>Treatment Process Used</b>	None.	POTW will provide treatment.	Ultra-violet oxidation.	Liquid-Phase Carbon Adsorption	Air stripping and vapor phase treatment with carbon or catalytic oxidation.	Biological treatment and liquid phase carbon adsorption.
<b>Amount Destroyed or Treated</b>	None.	Contaminants in extracted groundwater will be treated. 525,000 to 3,160,000 gal treated annually.	All contaminants will be destroyed in process. 790,000 to 3,160,000 gal. treated annually.	Contaminants transferred to carbon, destroyed during regeneration. 790,000 to 3,160,000 gal. treated annually.	Contaminants removed from groundwater. 790,000 to 3,160,000 gal treated annually.	Known to treat organic compounds. Chlorinated compounds will be adsorbed on carbon and destroyed during regeneration. 790,000 to 3,160,000 gal. treated annually.
<b>Reduction of Toxicity, Mobility, or Volume</b>	None.	Toxicity, mobility, and volume reduced.	See Alternative II.	See Alternative II.	See Alternative II.	To be determined.
<b>Irreversible Treatment</b>	None.	Depends on POTW.	Irreversibly destroyed by UV oxidation.	Irreversibly destroyed during carbon regeneration.	See Alternative III.	Altered if biodegraded. Irreversibly destroyed during regeneration of carbon (if adsorbed on carbon)
<b>Type &amp; Quantity of Residuals Remaining after Treatment</b>	No treatment, so most contamination remains.	Unknown, long-term treatment would be needed to eliminate contamination in aquifer, no residuals in treated groundwater.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
<b>Statutory Preference for Treatment</b>	Does not satisfy.	May not satisfy.	Satisfies.	Satisfies.	Satisfies.	Satisfies.
<b>Community Protection</b>	Possible migration to drinking water aquifer may endanger community.	Intallation and operation would not endanger community.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.

**TABLE 3.1 EVALUATION OF FINAL GROUNDWATER ALTERNATIVES**

<b>Criteria</b>	<b>Alternative I <u>No Action</u></b>	<b>Alternative II <u>Discharge to POTW</u></b>	<b>Alternative III <u>UV Oxidation</u></b>	<b>Alternative IV <u>Carbon Adsorption</u></b>	<b>Alternative V <u>Air Stripping</u></b>	<b>Alternative VI <u>Biological Treatment w/Carbon Adsorption</u></b>
<b><u>SHORT-TERM EFFECTIVENESS</u></b>						
Worker Protection	No significant risk to workers.	Protection from contaminated cuttings from well drilling.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
Environmental Impacts	Continued impact from existing conditions.	Aquifer drawdown may occur, no other impacts.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
Time Until Action is Complete	Not applicable.	Estimated to be 10 years.	Estimated to be 10 years.	Estimated to be 10 years.	Estimated to be 10 years.	Estimated to be 10 years.
<b><u>IMPLEMENTABILITY</u></b>						
Ability to Construct and Operate	No construction or operation.	Easy to construct, currently in operation.	Easy to construct. May be most difficult alternative to operate.	Easy to construct and operate.	Most difficult construct. Operation more difficult than carbon.	Easy to construct. Operation subject to environmental upsets, e.g. temperature, pH
Ease of Doing More Action if Needed	If more action determined to be necessary, may need to go through FS/ROD process.	Additional treatment process units can be added without difficulty.	See Alternative II.	See Alternative II.	See Alternative II.	See Alternative II.
Ability to Monitor Effectiveness	No monitoring.	Monitor well network in place.	Treated effluent can be readily monitored.	See Alternative III.	See Alternative III.	See Alternative III.
Ability to Obtain Approvals and Coordinate with Other Agencies	Unlikely approval would be obtained.	POTW will have to permit increased volume of discharge.	See Alternative II. Concentrations should comply with current permit.	See Alternative III.	See Alternative III.	See Alternative III.
Availability of Services and Capacities	No services or capacities required.	POTW able to handle increased volume.	Service will be provided by vendor. Monitoring services to be procured.	See Alternative III.	Service will need to be procured as well as monitoring.	See Alternative III.



TABLE 3.1 EVALUATION OF FINAL GROUNDWATER ALTERNATIVES

Criteria	Alternative I <u>No Action</u>	Alternative II <u>Discharge to POTW</u>	Alternative III <u>UV Oxidation</u>	Alternative IV <u>Carbon Adsorption</u>	Alternative V <u>Air Stripping</u>	Alternative VI <u>Biological Treatment w/Carbon Adsorption</u>
<u>IMPLEMENTABILITY (cont.)</u>						
Availability of Equipment, Specialist and Materials	None required.	See Alternative I.	UV equipment/process chemicals available. Specialist needed to optimize operation.	Carbon and associated equipment readily available.	Air stripper, carbon and catalytic oxidizer needed, readily available.	Reactor vessel and carbon beds needed, readily available.
Availability of Technologies	None required.	See Alternative I.	UV technology available.	Carbon technology available.	Air stripping and emission control technology available.	Biodegradation and carbon technology available.
<u>COST</u>						
Capital Cost	0	\$30,000	\$186,000	\$38,400	\$46,000	\$89,400
Annual Operating Cost	0	\$7,000	\$31,000	\$32,800	\$12,000	\$12,000 to \$26,400
Present Worth Cost (assume 10% discount rate)	0	\$72,000	\$370,000	\$240,000	\$120,000 (does not include emission control)	\$160,000 to \$248,000

TABLE 3.2 EVALUATION OF FINAL SOIL ALTERNATIVES

<u>Criteria</u>	<u>Alternative I</u> <u>No Action</u>	<u>Alternative II</u> <u>Off-site Treatment</u>	<u>Alternative III</u> <u>Enhanced Bio-Treatment</u>	<u>Alternative IV</u> <u>X-19 Treatment</u>	<u>Alternative V</u> <u>Excalibur Process</u>
<u>OVERALL PROTECTIVENESS</u>					
Human Health Protection - Direct Contact/ Soil Ingestion	No reduction in risk.	Will reduce risk since soil will be excavated and taken off-site.	Will reduce risk by excavating and treating soil.	Treatability study to determine effectiveness of X-19.	Treatability study to determine effectiveness of Excalibur Process.
Environmental Protection	Contaminants would continue to migrate to groundwater.	Soil would be removed and prevent further migration of contamination to groundwater.	See Alternative II.	See Alternative II.	See Alternative II.
<u>COMPLIANCE WITH ARARs</u>					
- Chemical Specific ARARs	Would not comply with ARARs.	Would comply with ARARs.	Expected to comply with ARARs.	To be determined.	To be determined.
<u>LONG-TERM EFFECTIVENESS AND PERMANENCE</u>					
Magnitude of Residual Risk - Direct Contact/ Soil Ingestion	Source and associated risk still remain.	Risk eliminated, source is removed.	See Alternative II.	See Alternative II.	See Alternative II.
Adequacy and Reliability of Controls	No controls over remaining contamination.  No reliability.	Treatment and disposal off-site will control contaminants adequately.  Reliable treatment method.	Contaminants would be controlled adequately. Contaminated soil contained, air effluent treated before emitted to atmosphere.  Reliable treatment. Only maintenance would be to maintain the biomass.	See Alternative IV. There may be no air emissions from this alternative.  Reliable treatment. Only maintenance would be to maintain the biomass.	See Alternative IV. There would be no air emissions from this process.  Reliability is unknown since the process has only recently been developed.
Need for 5-year Review	Should be performed to ensure adequate protection of human health and environment	Not necessary, treatment may not take 5 years.	See Alternative II.	See Alternative II.	See Alternative II.

TABLE 3.2 EVALUATION OF FINAL SOIL ALTERNATIVES

<u>Criteria</u>	<u>Alternative I No Action</u>	<u>Alternative II Off-site Treatment</u>	<u>Alternative III Enhanced Bio-Treatment</u>	<u>Alternative IV X-19 Treatment</u>	<u>Alternative V Excalibur Process</u>
<u>REDUCTION OF TOXICITY, MOBILITY, AND/OR VOLUME</u>					
Treatment Process Used	None.	Off-site incineration.	Biological degradation and vapor extraction.	Biological degradation.	Soil washing and UV oxidation of wash solution.
Amount Destroyed or Treated	None.	All contaminants present destroyed.	Organic compounds biodegraded, chlorinated compounds transferred to carbon.	Vendor claims X-19 will degrade all compounds present. Treatability study recommended.	Vendor claims process will destroy all compounds present. Treatability study recommended.
Reduction of Toxicity, Mobility, or Volume	None.	Reduced toxicity, mobility and volume .	See Alternative II.	To be determined.	To be determined.
Irreversible Treatment	None.	Incineration would be irreversible.	Biodegradation would be irreversible. Contaminants transferred to carbon would be irreversibly destroyed during regeneration.	Biodegradation would be irreversible.	Vendor claims process would be irreversible.
Type & Quantity of Residuals Remaining after Treatment	No treatment, so most contamination remains.	None.	Very low levels of organic contaminants may remain.	To be determined.	To be determined.
Statutory Preference for Treatment	Does not satisfy.	Does not satisfy.	Satisfies.	Satisfies.	Satisfies.
<u>SHORT-TERM EFFECTIVENESS</u>					
Community Protection	Migration of contaminants to groundwater may increase risk to public.	Engineering controls will be protective of community.	See Alternative II.	See Alternative II.	See Alternative II.
Worker Protection	No significant risk to workers.	See Alternative I.	See Alternative I.	See Alternative I.	See Alternative I.

TABLE 3.2 EVALUATION OF FINAL SOIL ALTERNATIVES

<u>Criteria</u>	<u>Alternative I</u> <u>No Action</u>	<u>Alternative II</u> <u>Off-site Treatment</u>	<u>Alternative III</u> <u>Enhanced Bio-Treatment</u>	<u>Alternative IV</u> <u>X-19 Treatment</u>	<u>Alternative V</u> <u>Excalibur Process</u>
<u>SHORT-TERM EFFECTIVENESS (cont.)</u>					
Environmental Impacts	Continued impact from existing conditions.	No impact.	No impact.	No impact.	No impact.
Time Until Action is Complete	Not applicable.	6 months.	1 to 2 years.	1 to 2 years.	1 to 2 years.
<u>IMPLEMENTABILITY</u>					
Ability to Construct and Operate	No construction or operation.	Simple to implement.	Construction and operation fairly straight forward.	Simple to construct and operate.	To be determined.
Ease of Doing More Action if Needed	May need to go through FS/ROD process to perform additional work.	Once incinerated, additional work would be difficult to perform.	Additional work would not be difficult to implement.	See Alternative III.	See Alternative III.
Ability to Monitor Effectiveness	No monitoring performed.	Treatment facility will determine effectiveness.	Monitoring can readily be performed.	See Alternative III.	See Alternative III.
Ability to Obtain Approvals and Coordinate with Other Agencies	Unlikely other agencies would accept this option.	Would be excecptable to other agencies.	Will meet substantive requirements of BAAQMD	See Alternative II.	See Alternative II.
Availability of Services and Capacities	No services or capacities required.	Need transportation and a treatment facility.	See Alternative I.	See Alternative I.	See Alternative I.
Availability of Equipment, Specialist, and Materials	None required.	Excavation equipment available.	Excavation equipment available.	Excavation equipment and X-19 additive available.	Process equipment will need to be fabricated.
Availability of Technologies	None required.	Limited number of incinerators.	Technology available.	Only one vendor of technology.	Only one vendor of technology.

TABLE 3.2 EVALUATION OF FINAL SOIL ALTERNATIVES

<u>Criteria</u>	<u>Alternative I</u> <u>No Action</u>	<u>Alternative II</u> <u>Off-site Treatment</u>	<u>Alternative III</u> <u>Enhanced Bio-Treatment</u>	<u>Alternative IV</u> <u>X-19 Treatment</u>	<u>Alternative V</u> <u>Excalibur Process</u>
<u>Cost</u>					
Capital Cost	\$0	\$1,400,000	\$165,000 to \$250,000	\$100,000	\$88,000 to \$220,000
Annual Operating Cost	\$0	\$293,000	\$200,000	\$200,000	\$200,000
Present Worth Cost (assume 10% discount rate)	\$0	\$1,693,000	\$365,000 to \$450,000	\$300,000	\$288,000 to \$420,000

TABLE 3.3  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVE III</u>
Federal and State Safe Drinking Water Act including National Primary Drinking Water Standards and Maximum Contaminant Level Goals (MCLGs)	Alternative does not provide for prevention of migration of groundwater to drinking water sources or aquifer restoration.	Alternative will remove A-aquifer groundwater containing contaminants in excess of MCLs and prevent lateral and vertical migration of contaminants.	Alternative will remove A-aquifer groundwater containing contaminants in excess of MCLs and prevent lateral and vertical migration of contaminants.
Federal Clean Water Act, including Water Quality Criteria, National Pollutant Discharge Elimination System and National Pretreatment Standards	Not applicable. Alternative does not involve treatment or discharge of wastes.	Extracted groundwater will continue to be discharged to POTW under existing permit with City of Mountain View. NPDES permit will not be required.	Extracted groundwater will continue to be discharged to POTW under existing permit with City of Mountain View. NPDES permit will not be required.
Federal Clean Air Act and State Air Resources Act including National Primary and Secondary Ambient Air Quality Standards and Bay Area Management Pollution Control District Rules and Regulations	Not applicable. Alternative does not involve on-site activities that would result in emission of regulated compounds.	Not applicable. Alternative does not involve on-site activities that would result in emission of regulated compounds.	Not applicable. Alternative does not involve on-site activities that would result in emission of regulated compounds.
Hazardous Waste Management Systems General	Not applicable. Alternative does not involve the generation or delisting of a hazardous waste.	Not applicable. No delisting of wastes will be required under this alternative.	Not applicable. No delisting of wastes will be required under this alternative.
Standards Applicable to Generators of Hazardous Waste	Not applicable. Alternative does not involve the generation and transportation of hazardous waste.	Not applicable. Alternative does not involve the generation and transportation of hazardous waste.	Not applicable. Alternative does not involve the generation and transportation of hazardous waste.

TABLE 3.3 (cont.)  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE IV</u>	<u>ALTERNATIVE V</u>	<u>ALTERNATIVE VI</u>
Federal and State Safe Drinking Water Act including National Primary Drinking Water Standards and Maximum Contaminant Level Goals (MCLGs)	Alternatives will remove A-aquifer groundwater containing contaminants in excess of MCLs and prevent lateral and vertical migration of contaminants.	Alternative will remove A-aquifer groundwater containing contaminants in excess of MCLs and prevent lateral and vertical migration of contaminants.	Alternatives will remove A-aquifer groundwater containing contaminants in excess of MCLs and prevent lateral and vertical migration of contaminants.
Federal Clean Water Act, including Water Quality Criteria, National Pollutant Discharge Elimination System and National Pretreatment Standards	Extracted groundwater will continue to be discharged to POTW under existing permit with City of Mountain View. NPDES permit will not be required.	Extracted groundwater will continue to be discharged to POTW under existing permit with City of Mountain View. NPDES permit will not be required.	Extracted groundwater will continue to be discharged to POTW under existing permit with City of Mountain View. NPDES permit will not be required.
Federal Clean Air Act and State Air Resources Act including National Primary and Secondary Ambient Air Quality Standards and Bay Area Management Pollution Control District Rules and Regulations	Not applicable. Alternatives do not involve on-site activities that would result in emission of regulated compounds.	Emissions from treatment facilities are not expected to exceed limits for control. Exemption from permit due to low emissions would be required.	Not applicable. Alternatives do not involve on-site activities that would result in emission of regulated compounds.
Hazardous Waste Management Systems General	Not applicable. No delisting of wastes will be required under this alternative.	Not applicable. No delisting of wastes will be required under this alternative.	Not applicable. No delisting of wastes will be required under this alternative.
Standards Applicable to Generators of Hazardous Waste	Generator standards will be met for management of treatment residues (e.g. spent carbon)	Not applicable. Alternative does not involve the generation and transportation of hazardous waste.	Generator standards will be met for management of treatment residues (e.g. spent carbon)

TABLE 3.3 (cont.)  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVE III</u>
RCRA – Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, including General Facility Standards, Preparedness and Prevention, Contingency Plan and Emergency Procedures, Manifest System, Record-keeping and Reporting, Releases from Solid Waste Management Units, Closure, Financial Requirements, Use and Management of Containers, Waste Piles, Miscellaneous Units	Not applicable. Alternative does not involve the treatment, storage or disposal of hazardous wastes.	Not applicable. Treated water will be discharged to POTW in accordance with Clean Water Act.	Not applicable. Treated water will be discharged to POTW in accordance with Clean Water Act.
Land Disposal Restrictions	Not applicable. Alternative does not involve the treatment, storage or disposal of hazardous wastes.	Not applicable. Alternative does not involve land disposal of solid wastes.	Not applicable. Alternative does not involve land disposal of solid wastes.
Federal and State Occupational Health and Safety Act	Not applicable. No on-site activities will be conducted.	Site Activities will be conducted in accordance with these acts.	Site Activities will be conducted in accordance with these acts.
Transportation of Wastes (Federal/ State) including Federal Hazardous Material Transportation Regulations/ Standards Applicable to Generators of Hazardous Waste and State Highway Patrol Hazardous Material Regs	Not applicable. Alternative does not involve the transportation of hazardous wastes.	Not applicable. Alternative does not involve the transportation of hazardous wastes.	Not applicable. Alternative does not involve the transportation of hazardous wastes.



TABLE 3.3 (cont.)  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE IV</u>	<u>ALTERNATIVE V</u>	<u>ALTERNATIVE VI</u>
RCRA – Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, including General Facility Standards, Preparedness and Prevention, Contingency Plan and Emergency Procedures, Manifest System, Record-keeping and Reporting, Releases from Solid Waste Management Units, Closure, Financial Requirements, Use and Management of Containers, Waste Piles, Miscellaneous Units	Spent carbon from groundwater treatment system will be transported and recycled (regenerated) in accordance with regulations.	Not applicable. Treated water will be discharged to POTW in accordance with Clean Water Act.	Spent carbon from groundwater treatment system will be transported and recycled (regenerated) in accordance with regulations.
Land Disposal Restrictions	Not applicable. Alternatives do not involve land disposal of solid wastes.	Not applicable. Alternative does not involve land disposal of solid wastes.	Not applicable. Alternatives do not involve land disposal of solid wastes.
Federal and State Occupational Health and Safety Act	Site Activities will be conducted in accordance with these acts.	Site Activities will be conducted in accordance with these acts.	Site Activities will be conducted in accordance with these acts.
Transportation of Wastes (Federal/ State) including Federal Hazardous Material Transportation Regulations/ Standards Applicable to Generators of Hazardous Waste and State Highway Patrol Hazardous Material Regs	Spent carbon from groundwater treatment system will be transported and recycled (regenerated) in accordance with regulations.	Not applicable. Alternative does not involve the transportation of hazardous wastes.	Spent carbon from groundwater treatment system will be transported and recycled (regenerated) in accordance with regulations.

TABLE 3.3 (cont.)  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVE III</u>
Air Toxics "Hot Spots" Information and Assessment Act	Not applicable. Alternative does not involve new facilities that would result in unacceptable air emissions.	Not applicable. Alternative does not involve new facilities that would result in unacceptable air emissions.	Not applicable. Alternative does not involve new facilities that would result in unacceptable air emissions.
Porter-Cologne Water Quality Control Act and California Water Quality Objectives	Alternative does not provide for A-aquifer restoration. A-aquifer does not meet State criteria as drinking water source.	Alternative will improve groundwater quality by removing contaminated groundwater and preventing contaminant migration. A-aquifer does not meet State criteria as a potential drinking water source.	Alternative will improve groundwater quality by removing contaminated groundwater and preventing contaminant migration. A-aquifer does not meet State criteria as a potential drinking water source.
Water Well Standards	Not applicable. No additional wells will be constructed.	Additional wells will be constructed according to Water Well Standards.	Additional wells will be constructed according to Water Well Standards.
California Hazardous Waste Management and Control Regulations including Waste Discharge Reports and Requirements, Discharge of Waste to Land, Hazardous Waste Control Laws, Hazardous Substance Account and Cleanup Bond Acts, Hazardous Substance Act and Criteria for Identification of Hazardous and Extremely Hazardous Wastes/Threshold Limit Conc.	Not applicable. No on-site activities will be conducted.	Extracted groundwater will be managed in accordance with State Hazardous Waste Control Regulations.	Extracted groundwater will be managed in accordance with State Hazardous Waste Control Regulations.
Underground Storage Tank Regulation and Underground Storage of Hazardous Substance Requirements	Not applicable. Alternative does not involve storage in or removal of underground storage facilities.	Not applicable. Alternative does not involve storage in, or removal of underground storage facilities.	Not applicable. Alternative does not involve storage in or removal of underground storage facilities.

TABLE 3.3 (cont.)  
DOCUMENTATION OF ARARs FOR GROUNDWATER REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE IV</u>	<u>ALTERNATIVE V</u>	<u>ALTERNATIVE VI</u>
Air Toxics "Hot Spots" Information and Assessment Act	Not applicable. Alternatives do not involve new facilities that would result in unacceptable air emissions.	Air emissions not expected to exceed unacceptable limits. Variance may be required.	Not applicable. Alternatives do not involve new facilities that would result in unacceptable air emissions.
Porter-Cologne Water Quality Control Act and California Water Quality Objectives	Alternative will improve groundwater quality by removing contaminated groundwater and preventing contaminant migration. A-aquifer does not meet State criteria as a potential drinking water source.	Alternative will improve groundwater quality by removing contaminated groundwater and preventing contaminant migration. A-aquifer does not meet State criteria as a potential drinking water source.	Alternative will improve groundwater quality by removing contaminated groundwater and preventing contaminant migration. A-aquifer does not meet State criteria as a potential drinking water source.
Water Well Standards	Additional wells will be constructed according to Water Well Standards.	Additional wells will be constructed according to Water Well Standards.	Additional wells will be constructed according to Water Well Standards.
California Hazardous Waste Management and Control Regulations including Waste Discharge Reports and Requirements, Discharge of Waste to Land, Hazardous Waste Control Laws, Hazardous Substance Account and Cleanup Bond Acts, Hazardous Substance Act and Criteria for Identification of Hazardous and Extremely Hazardous Wastes/Threshold Limit Conc.	Extracted groundwater will be managed in accordance with State Hazardous Waste Control Regulations.	Extracted groundwater will be managed in accordance with State Hazardous Waste Control Regulations.	Extracted groundwater will be managed in accordance with State Hazardous Waste Control Regulations.
Underground Storage Tank Regulation and Underground Storage of Hazardous Substance Requirements	Not applicable. Alternatives do not involve storage in or removal of underground storage facilities.	Not applicable. Alternative does not involve storage in or removal of underground storage facilities.	Not applicable. Alternatives do not involve storage in or removal of underground storage facilities.

TABLE 3.4  
DOCUMENTATION OF ARARs FOR SOIL REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVES III TO V</u>
Federal and State Safe Drinking Water Act including National Primary Drinking Water Standards and Maximum Contaminant Level Goals (MCLGs)	Not applicable. Alternative does not address groundwater quality.	Alternative does not involve groundwater remediation. The removal of contaminated soil will likely result in a decrease in the presence and concentrations of contaminants in groundwater.	Alternatives do not involve groundwater remediation. The removal of contaminated soil will likely result in a decrease in the presence and concentrations of contaminants in groundwater.
Federal Clean Water Act, including Water Quality Criteria, National Pollutant Discharge Elimination System and National Pretreatment Standards	Not applicable. Alternative does not involve treatment or discharge of wastes	Not applicable. Alternative does not involve on-site treatment or discharge of wastes to waterways.	Not applicable. Alternatives do not involve on-site treatment or discharge of wastes to waterways.
Federal Clean Air Act and State Air Resources Act including National Primary and Secondary Ambient Air Quality Standards and Bay Area Management Pollution Control District Rules and Regulations	Not applicable. Alternative does not involve removal of soil.	Soil removal will be conducted in accordance with air quality regulations as administered by BAAQMD.	Soil removal will be conducted in accordance with air quality regulations as administered by BAAQMD.
Hazardous Waste Management Systems General	Not applicable. Alternative does not involve the generation or delisting of a hazardous waste.	No delisting will be required. Excavated soil will be treated and disposed off-site.	Soil replaced on-site after treatment may require waste delisting.
Standards Applicable to Generators of Hazardous Waste	Not applicable. Alternative does not involve the generation or transportation of hazardous waste.	Generator standards will be met for the generation and off-site disposal of hazardous waste.	Generator standards will be met for the generation, treatment and disposal of hazardous waste.

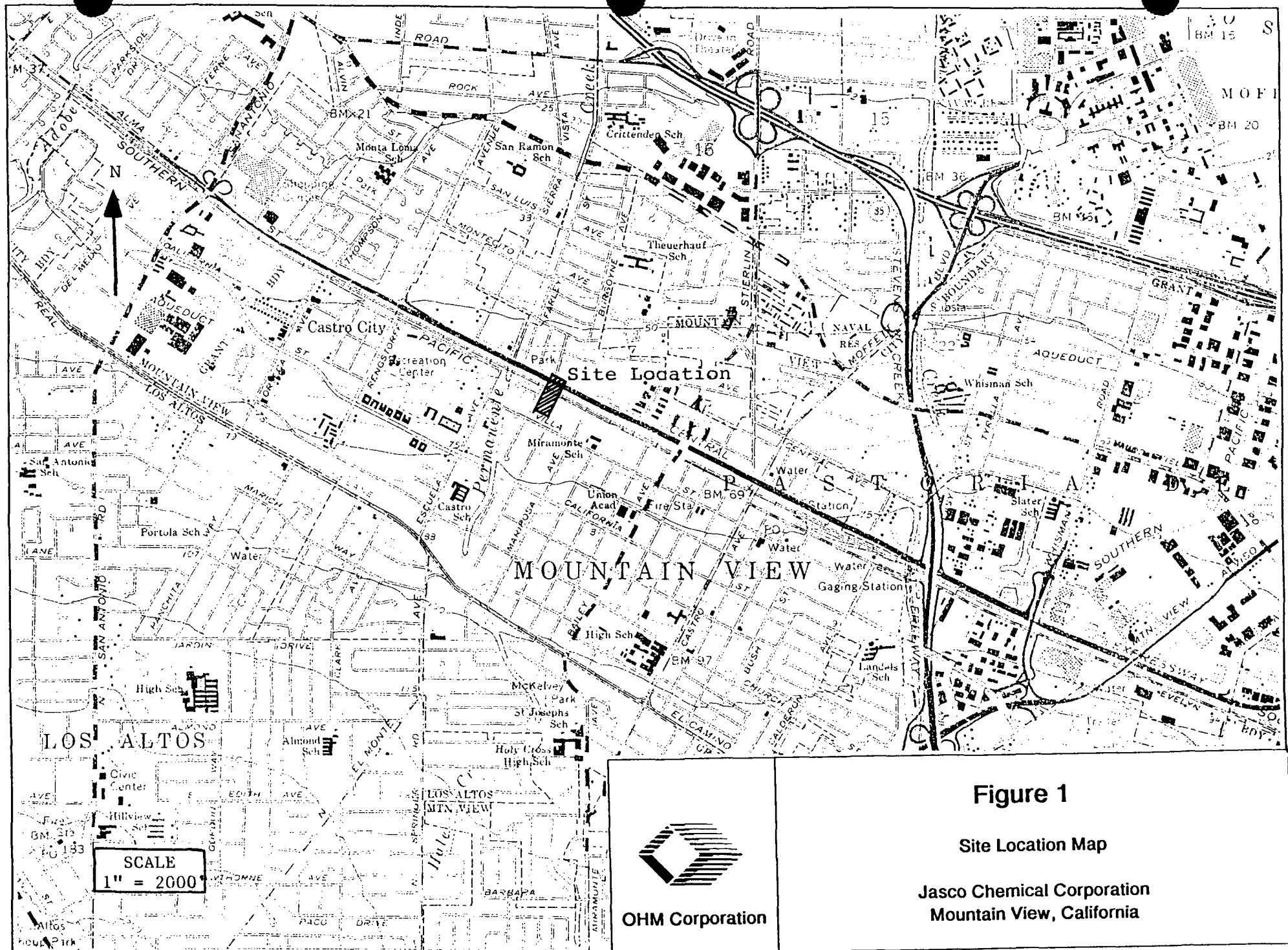
TABLE 3.4  
DOCUMENTATION OF ARARs FOR SOIL REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVES III TO V</u>
RCRA – Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, including General Facility Standards, Preparedness and Prevention, Contingency Plan and Emergency Procedures, Manifest System, Record-keeping and Reporting, Releases from Solid Waste Management Units, Closure, Financial Requirements, Use and Management of Containers, Waste Piles, Misc. Units	Not applicable. Alternative does not involve the treatment, storage or disposal of hazardous wastes.	Excavated soil will be transported and treated off-site in accordance with RCRA. Transportation of wastes will comply with manifesting procedures.	Excavated soil will be treated on-site in accordance with RCRA. Remedial Design Report is likely to satisfy requirements for facility permit for soil treatment. Closure/Post-Closure procedures may be applicable for land treatment unit after soil treatment is complete.
Land Disposal Restrictions	Not applicable. Alternative does not involve the treatment, storage or disposal of hazardous wastes.	TSDF will ensure wastes transported off-site will conform with land disposal restrictions.	Treated soil is expected to conform with land disposal restrictions for on-site replacement.
Federal and State Occupational Health and Safety Act	Not applicable. No on-site activities would be conducted.	Site activities will be conducted in accordance with these acts.	Site activities will be conducted in accordance these acts.
Transportation of Wastes (Federal and State) including Federal Hazardous Material Transportation Regulations and Standards Applicable to Generators of Hazardous Waste and California Highway Patrol Hazardous Material Regulations	Not applicable. Alternative does not involve the transportation of hazardous wastes.	Hazardous materials will be transported by a licensed hazardous waste transporter in accordance with State and Federal regulations.	Not applicable. Soil will be treated to acceptable levels and replaced on-site.

TABLE 3.4  
DOCUMENTATION OF ARARs FOR SOIL REMEDIAL ALTERNATIVES  
JASCO CHEMICAL CORPORATION SITE  
MOUNTAIN VIEW, CALIFORNIA

<u>STATUTE OR REGULATION</u>	<u>ALTERNATIVE I</u>	<u>ALTERNATIVE II</u>	<u>ALTERNATIVES III TO V</u>
Air Toxics "Hot Spots" Information and Assessment Act	Not applicable. Alternative does not involve construction of new facilities.	No on-site treatment. Emissions of regulated compounds are not expected.	Alternatives will employ measures to contain and control unacceptable air emissions.
Porter-Cologne Water Quality Control Act and California Water Quality Objectives	Not applicable. Alternative does not address groundwater quality.	Not applicable. Alternative does not involve groundwater remediation.	Not applicable. Alternatives do not involve groundwater remediation.
Water Well Standards	Not applicable. No additional wells would be constructed.	Not applicable. Alternative does not involve well construction.	Not applicable. Alternatives do not involve well construction.
California Hazardous Waste Management and Control Regulations including Waste Discharge Reports and Requirements, Discharge of Waste to Land, Hazardous Waste Control Laws, Hazardous Substance Account Act, Hazardous Substance Cleanup Bond Act, Hazardous Substance Act and Criteria for Identification of Hazardous and Extremely Hazardous/Wastes/Threshold Limit Conc.	Not applicable. Alternative does not involve the removal of soil.	Excavated soil will be transported and treated off-site in accordance with State hazardous waste control regulations.	Excavated soil will be treated on-site in accordance with State Hazardous Waste Control Requirements. Treated soil replaced on-site may require a variance from State hazardous waste disposal regulations.
Underground Storage Tank Regulation and Underground Storage of Hazardous Substance Requirements	Not applicable. Alternative does not involve storage in or removal of underground storage facilities.	Not applicable. Alternative does not involve storage in, or removal of underground storage facilities.	Not applicable. Alternatives do not involve storage in or removal of underground storage facilities.

**FIGURES**





DRAWING NUMBER 0007403-A1.2

APPROVED BY

CHECKED BY

DRAWN BY E. Kwong 12-11-90

OHM CORPORATION  
WALNUT CREEK, CA

PLOT SCALE: 1" = 110'

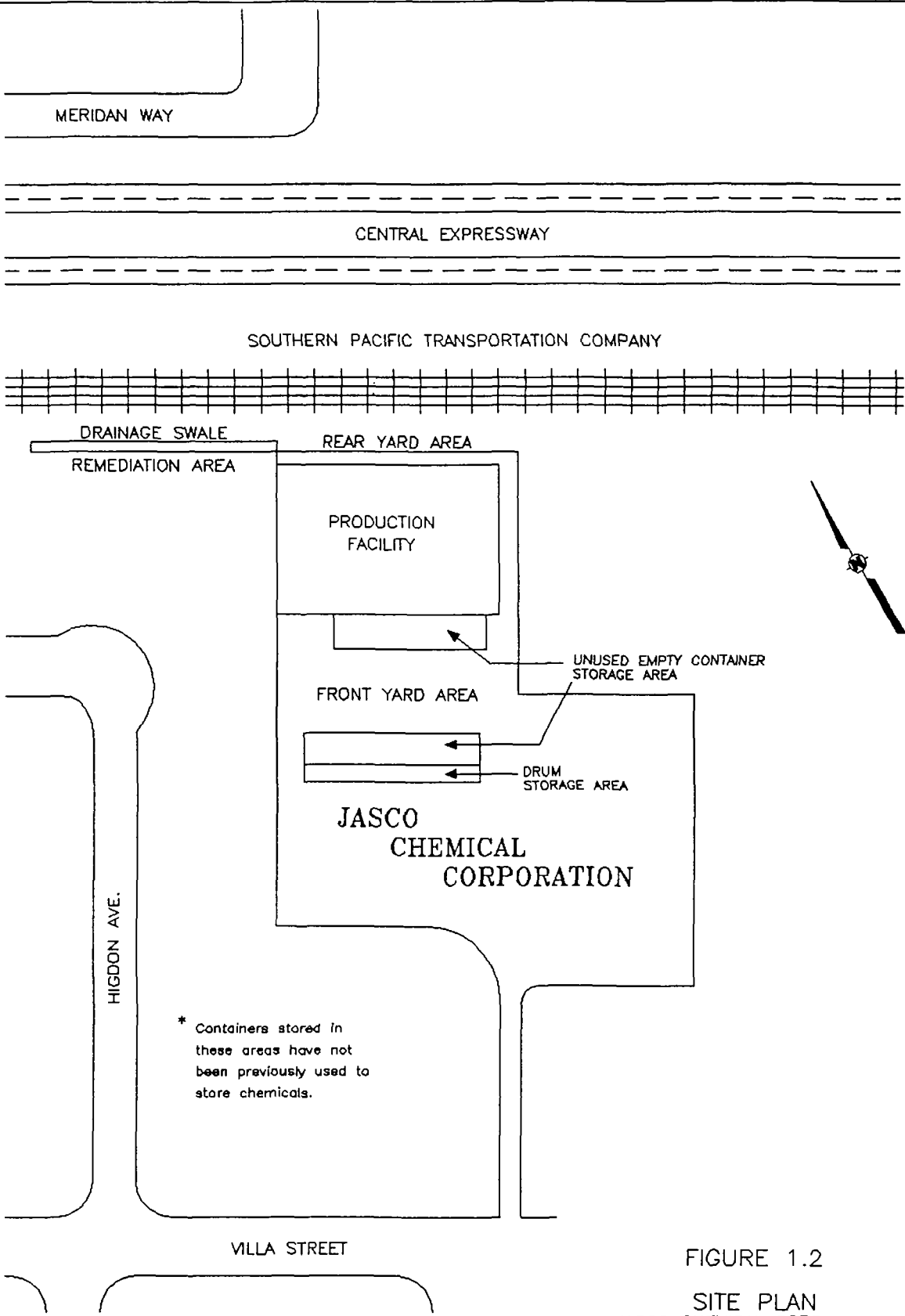
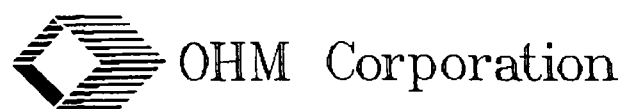


FIGURE 1.2

SITE PLAN  
JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA

PREPARED FOR

JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA



DRAWING NUMBER 0007403-A1.3

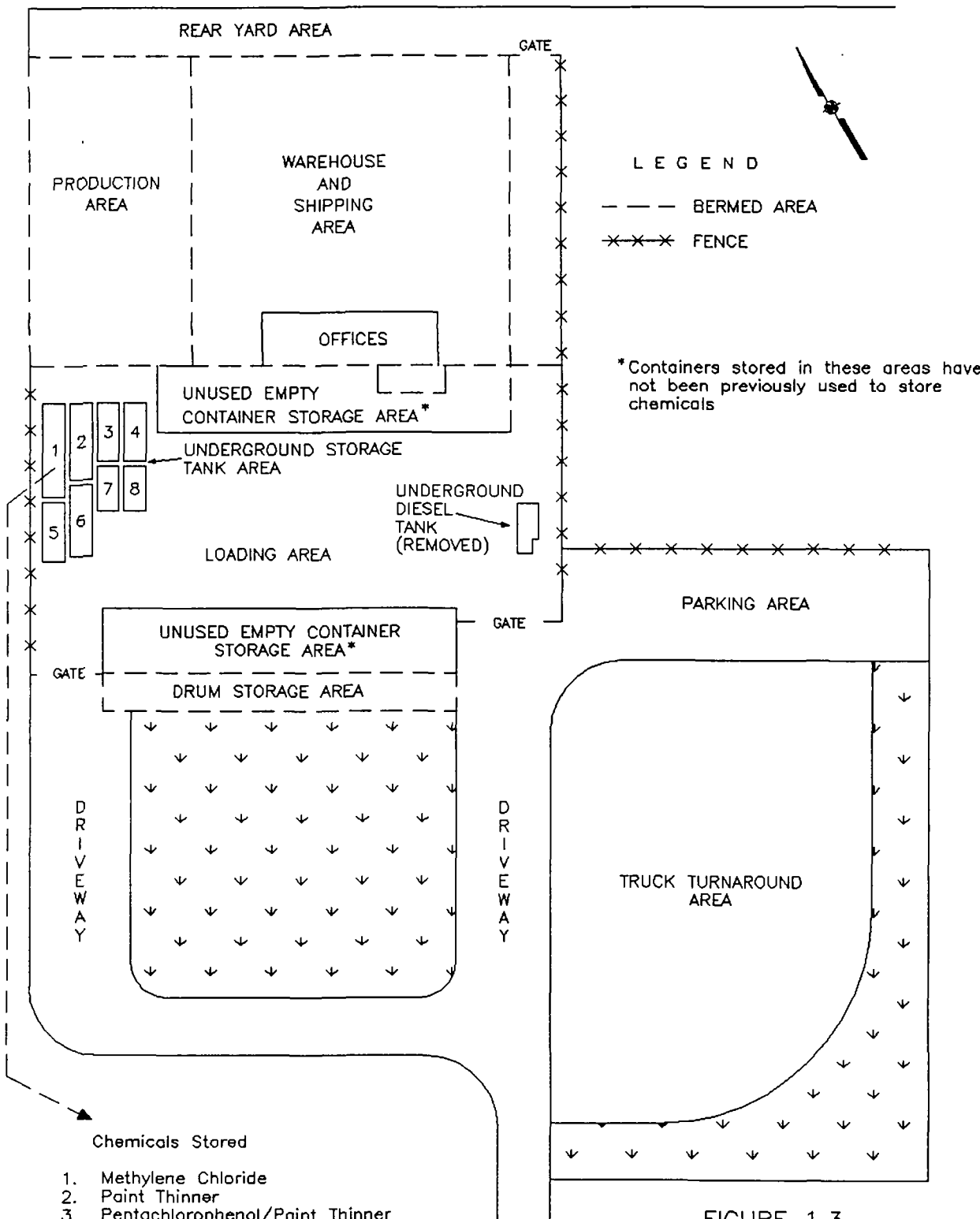
APPROVED BY

CHECKED BY

DRAWN BY

OHM CORPORATION  
WALNUT CREEK, CA  
E. Kwong 12-11-90

PLOT SCALE: 1"=50'



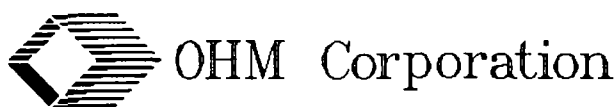
- Chemicals Stored
1. Methylene Chloride
  2. Paint Thinner
  3. Pentachlorophenol/Paint Thinner
  4. Denatured Alcohol
  5. Methanol
  6. Deodorized Kerosene
  7. Lacquer Thinner
  8. Acetone

FIGURE 1.3

EXISTING AND FORMER STRUCTURES  
JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA

PREPARED FOR

JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA



OHM CORPORATION  
 WALNUT CREEK, CA  
 DRAWN BY  
 E. Kwong  
 12-11-90  
 CHECKED BY  
 APPROVED BY  
 DRAWING NUMBER  
 0007403-A1.4  
 PLOT SCALE: 1" = 110'

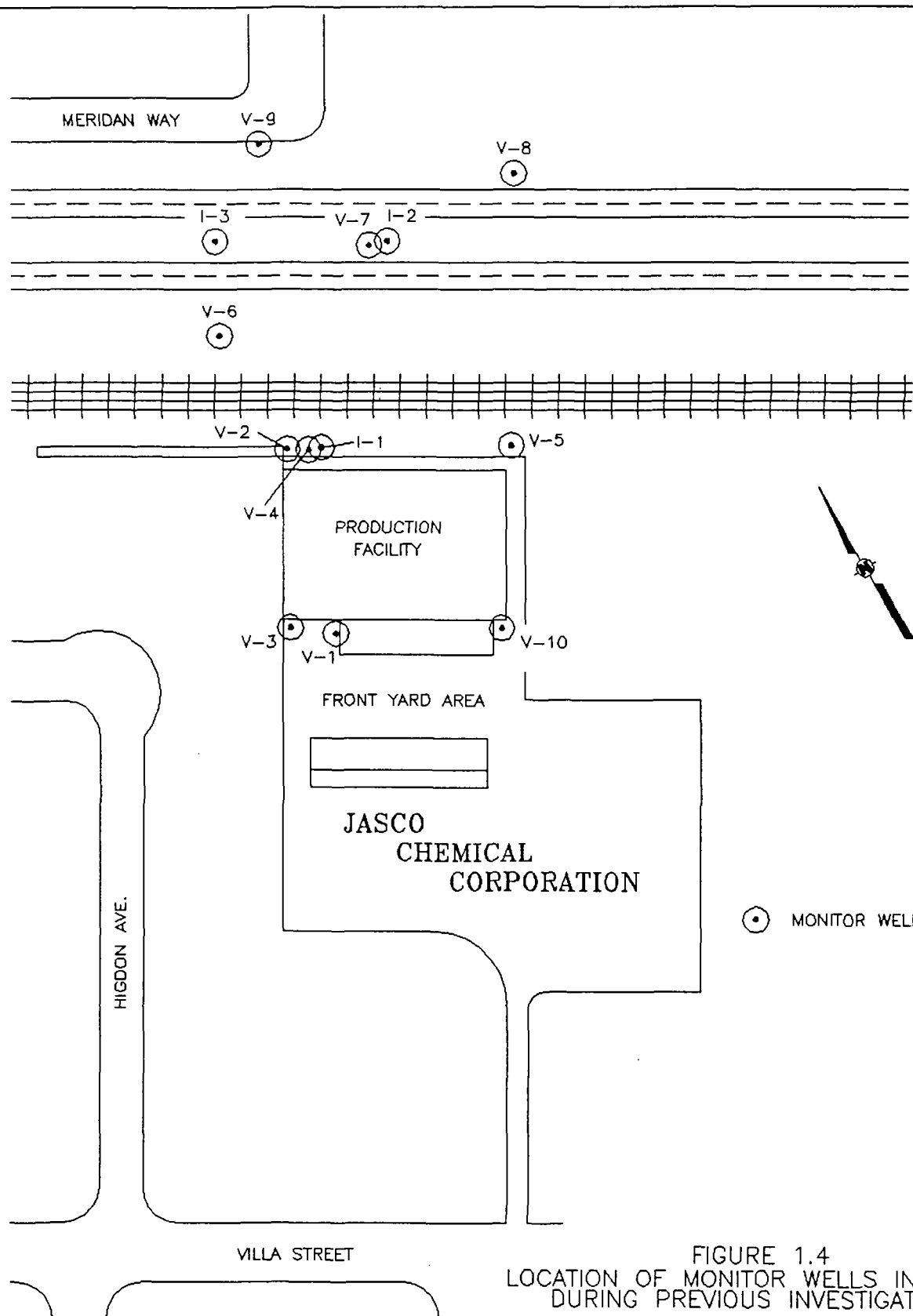


FIGURE 1.4  
 LOCATION OF MONITOR WELLS INSTALLED  
 DURING PREVIOUS INVESTIGATIONS

JASCO CHEMICAL CORPORATION  
 MOUNTAIN VIEW, CALIFORNIA

PREPARED FOR

JASCO CHEMICAL CORPORATION  
 MOUNTAIN VIEW, CALIFORNIA

PLOT SCALE = 1"=30'

OHM CORPORATION  
WALNUT CREEK, CA

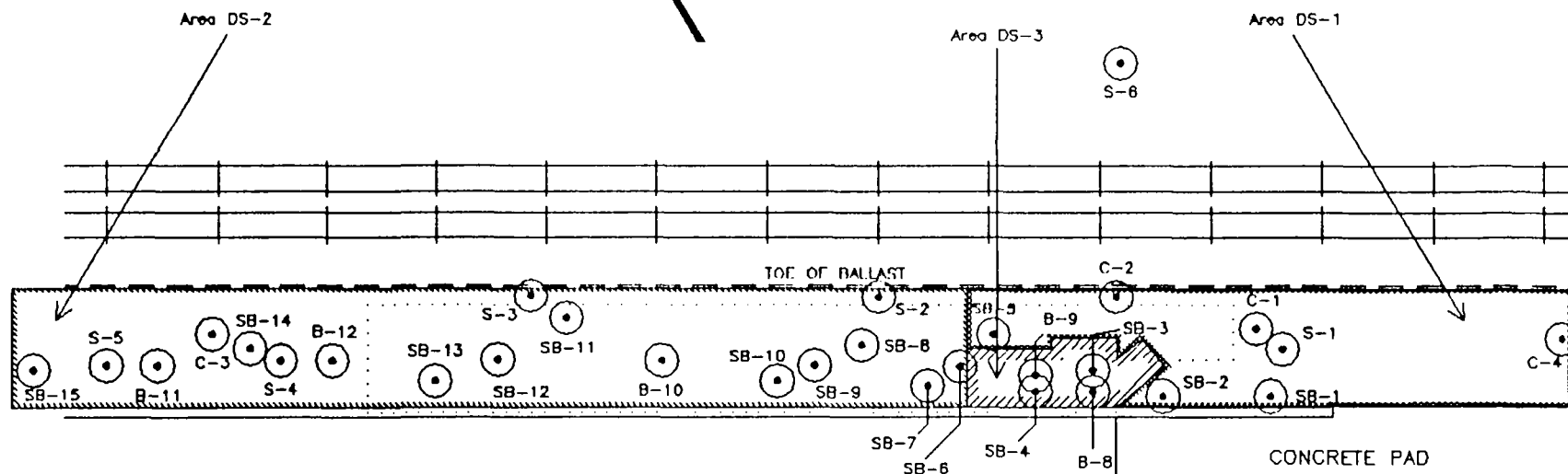
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E. Kwong 12-18-90

CHECKED BY

APPROVED BY

DRAWING  
NUMBER 0007402-A4.1

CENTRAL EXPRESSWAY



Legend



Borehole Location

..... Impermeable Membrane Runoff Collection System

FIGURE 1.5  
LOCATION OF SAMPLE POINTS AND  
DELINEATION OF DRAINAGE SWALE AREAS

JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CA

PREPARED FOR

JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CA



OHM Corporation

PLOT SCALE = 1"=30'

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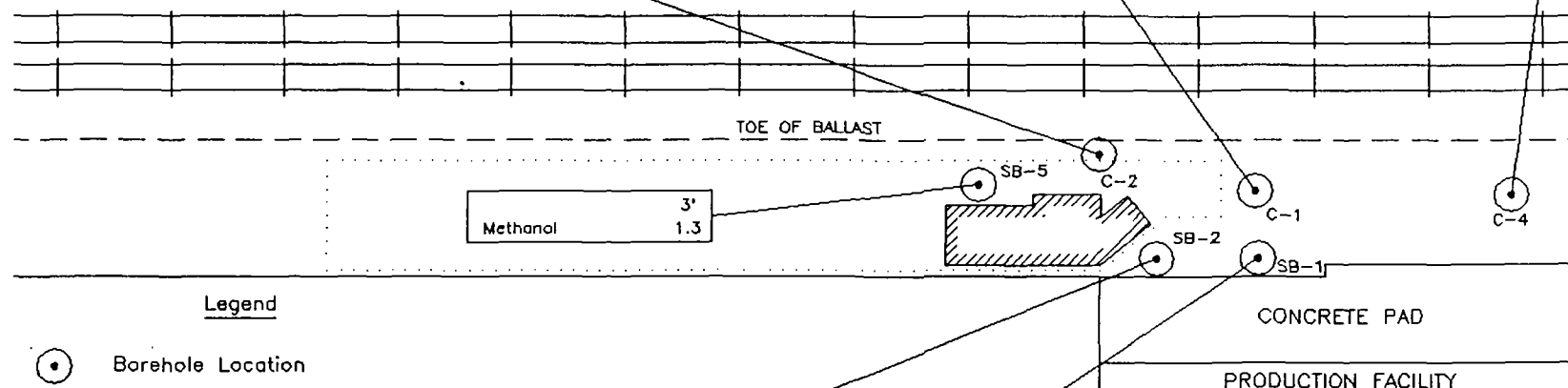
DRAWING NUMBER 0007403-A4.4

CENTRAL EXPRESSWAY

	3'	5'	10'	15'	20'	25'	30'
1,1-DCA	0.02	0.016	0.036	0.11	0.063	0.41	ND
1,1-DCE	ND	ND	ND	0.03	ND	0.036	ND
1,2-DCE	ND	ND	ND	ND	ND	0.015	ND
1,1,1-TCA	0.099	0.052	0.016	0.095	0.052	0.016	ND
Bromoform	ND	ND	ND	ND	ND	0.019	ND
Methylene Chloride	ND	ND	0.14	0.27	0.71	ND	ND
Trichloroethene	0.015	ND	ND	0.0073	ND	ND	ND
Low-Med BP HC	ND	ND	ND	2800	1300	2600	ND
Toluene	0.023	ND	ND	0.005	ND	0.085	0.018
Xylene	ND	ND	ND	0.01	ND	0.038	0.026

	3'	5'	10'	15'	20'	25'	30'
1,1-DCA	0.12	0.38	0.038	ND	0.72	2.2	3
1,1-DCE	0.39	1.7	0.025	0.17	0.24	0.15	ND
1,1,1-TCA	15	61	0.59	5.3	6.8	ND	ND
Bromoform	ND	ND	ND	ND	ND	0.17	0.11
Methylene Chloride	0.9	ND	0.75	ND	4.2	3.2	ND
Tetrachloroethene	ND	0.065	ND	0.052	ND	4	ND
Trichloroethene	ND	0.05	ND	ND	ND	ND	ND
Isopropanol	76	ND	ND	ND	ND	ND	ND
Methanol	60	ND	ND	ND	ND	ND	ND
Low-Med BPHC	2600	6700	170	1300	120	380	38
Toluene	37	110	1.1	3.4	4.1	6.3	1.4
Xylene	11	37	0.87	5.5	2.6	5.9	1.5
Ethylbenzene	ND	ND	ND	ND	ND	ND	0.37

No concentrations  
exceeding detection  
limit.



Legend

- Borehole Location
- Impermeable Membrane Runoff Collection System
- ▨ Area of Interim Soil Excavation
- All concentrations of contaminants given in mg/kg

	3'
1,1-DCA	1.4
1,1,1-TCA	2.6
Acetone	6.3
Methylene Chloride	1.7
Toluene	0.3
Acetone	8.8
Methanol	5.0
TPH (Kerosene)	10
TPH (Paint Thinner)	5.2

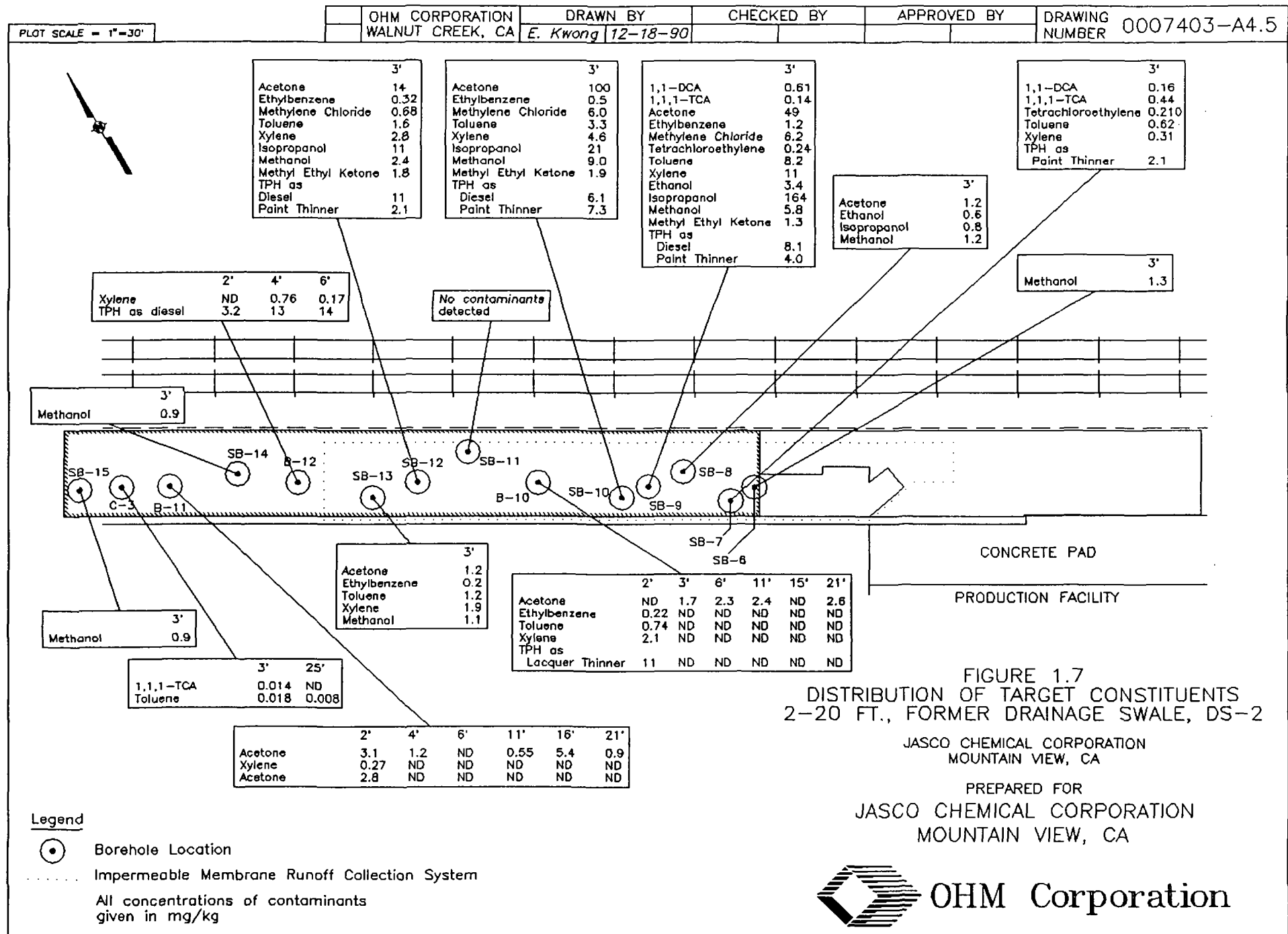
	3'
1,1-DCA	0.54
1,1,1-TCA	1.1
Methylene Chloride	1.3
Acetone	1.1
Ethanol	0.7
Methanol	3.3

FIGURE 1.6  
DISTRIBUTION OF TARGET CONSTITUENTS  
3-30', FORMER DRAINAGE SWALE, DS-1

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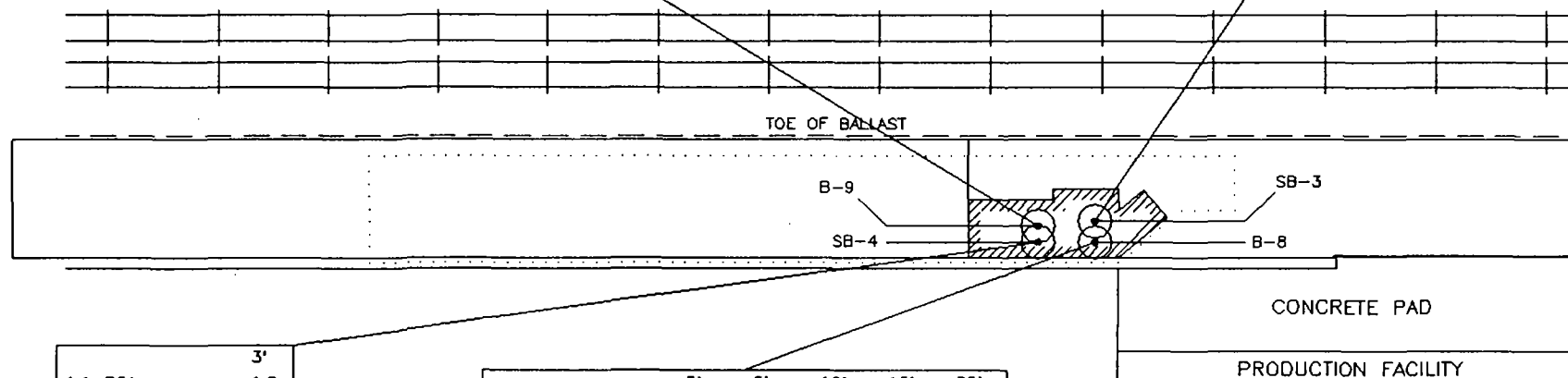
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	2'	4'	8'	11'	16'	21'
1,1-DCA	ND	2.2	0.68	0.23	ND	ND
1,1-DCE	0.16	ND	ND	ND	ND	ND
1,1,1-TCA	0.34	30	28	0.29	ND	ND
2-Propanone	24	25	6.2	5.1	ND	ND
Bromodichloromethane	0.16	ND	ND	ND	ND	ND
Ethylbenzene	ND	3	4.2	ND	ND	ND
Methylene Chloride	9.3	42	21	7.4	16	15
Tetrachloroethane	ND	0.87	1.3	ND	ND	ND
TCE	ND	1.4	1.5	ND	ND	ND
Toluene	2.3	38	41	0.27	ND	ND
Xylene	0.45	18	27	ND	ND	ND
Acetone	16	25	1.8	27	12	4
Isopropanol	ND	1.5	ND	ND	ND	ND
TPH as						
Lacquer Thinner	16	ND	ND	ND	ND	ND
Paint Thinner	98	5000	2000	29	ND	ND

	3'
1,1,1-TCA	47
Acetone	91
Methylene Chloride	210
Toluene	38
Xylene	27
Ethanol	20
Isopropanol	18
Methanol	32
TPH as	
Kerosene	150
Paint Thinner	320



	3'
1,1-DCA	1.2
1,1,1-TCA	7.3
Acetone	28
Ethylbenzene	2.2
Methylene Chloride	64
Tetrachloroethylene	1.0
TCE	0.56
Toluene	17
Xylene	210
Isopropanol	60
Methanol	14
TPH as	
Kerosene	140
Paint Thinner	320

	3'	5'	10'	15'	20'
1,1-DCA	27	34	0.98	0.2	0.76
1,1-DCE	13	ND	ND	ND	ND
1,1,1-TCA	ND	1.5	22	2.3	0.21
1,2-DCA	3.9	ND	ND	ND	ND
Carbon Tetrachloride	850	ND	ND	ND	ND
Chloroform	2.3	ND	ND	ND	ND
Ethylbenzene	170	NA	NA	NA	NA
Methylene Chloride	3400	2.4	71	8.9	18
Tetrachloroethane	16	0.0067	0.31	ND	ND
TCE	490	ND	0.85	0.088	ND
Toluene	1700	NA	NA	NA	NA
Acetone	270	NA	15	NA	13
Isopropanol	3.5	NA	1	NA	2.5
TPH as					
Paint Thinner	11000	NA	2600	NA	20

Legend



Borehole Location

..... Impermeable Membrane Runoff Collection System

All concentrations of contaminants given  
in mg/kg

FIGURE 1.8  
DISTRIBUTION OF TARGET CONSTITUENTS  
2-30', FORMER DRAINAGE SWALE, DS-3

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PLOT SCALE: 1"=50'

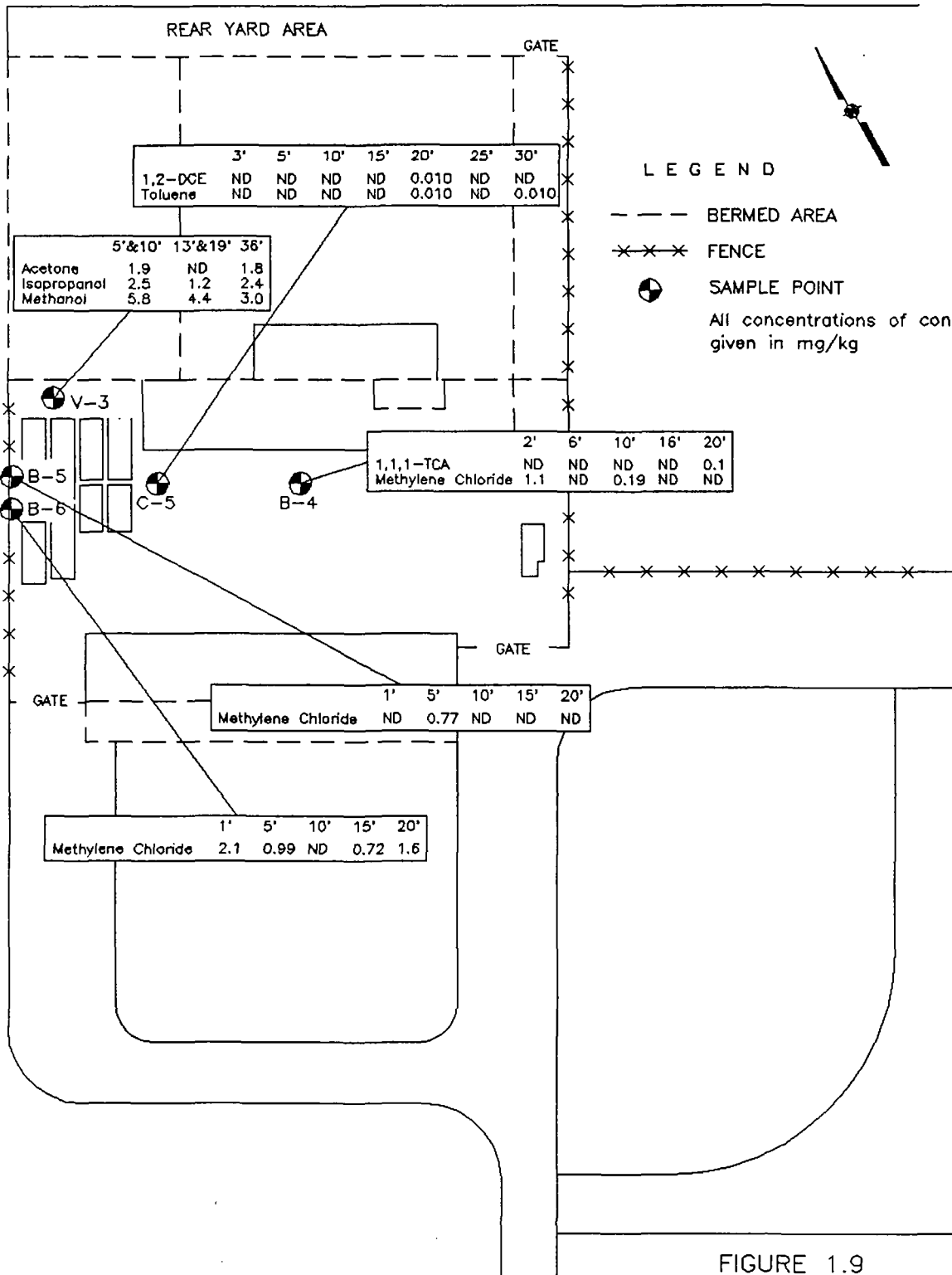


FIGURE 1.9  
DISTRIBUTION OF TARGET CONSTITUENTS  
UNDERGROUND STORAGE TANK AREA  
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PLOT SCALE: 1"=50'

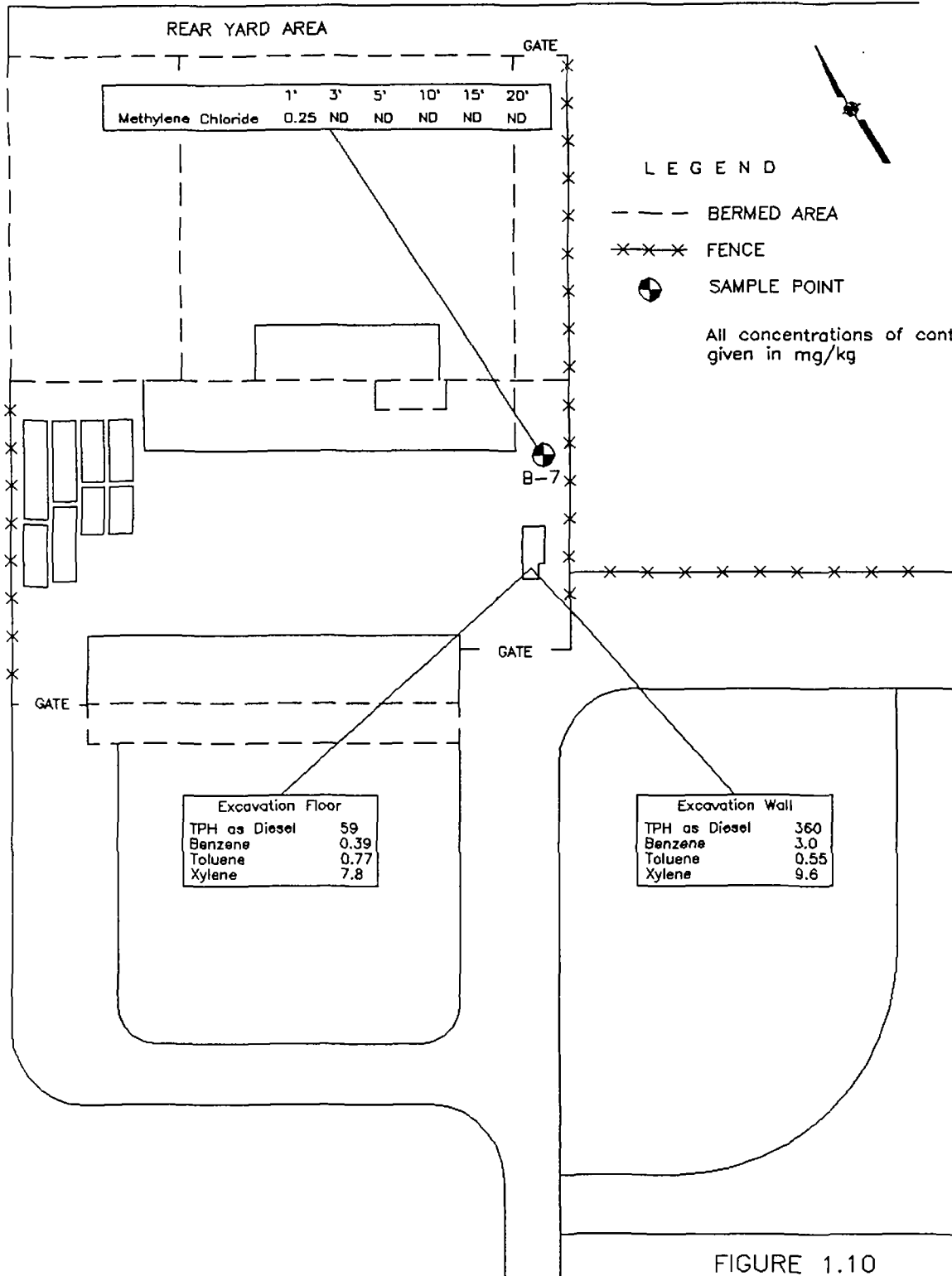


FIGURE 1.10  
DISTRIBUTION OF TARGET CONSTITUENTS  
FORMER UNDERGROUND DIESEL TANK  
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PLOT SCALE: 1"=50'

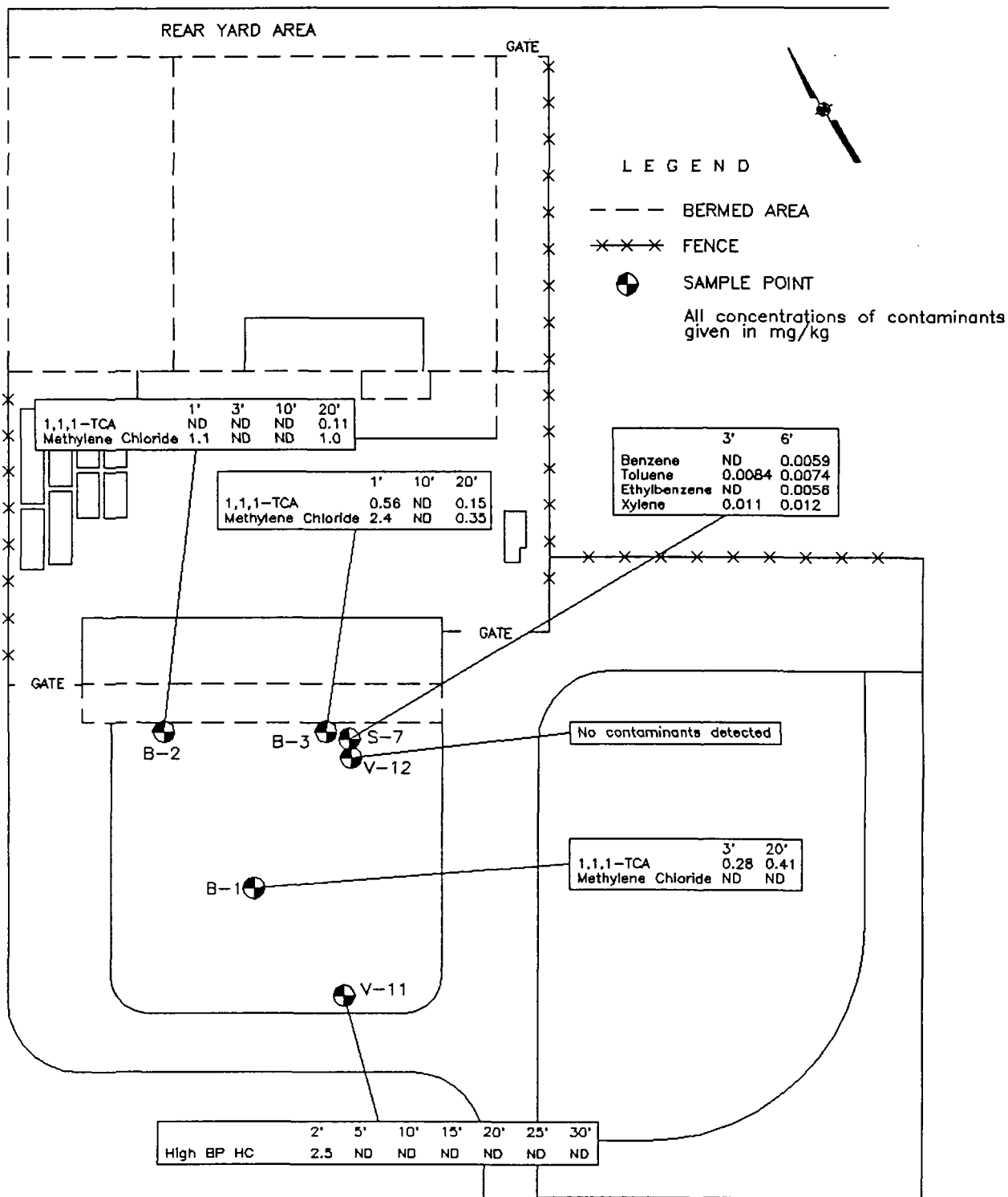


FIGURE 1.11  
DISTRIBUTION OF TARGET CONSTITUENTS  
DRUM STORAGE & BACKGROUND AREA  
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 DRAWING NUMBER  
 0007403-A1.4  
 PLOT SCALE: 1" = 110'

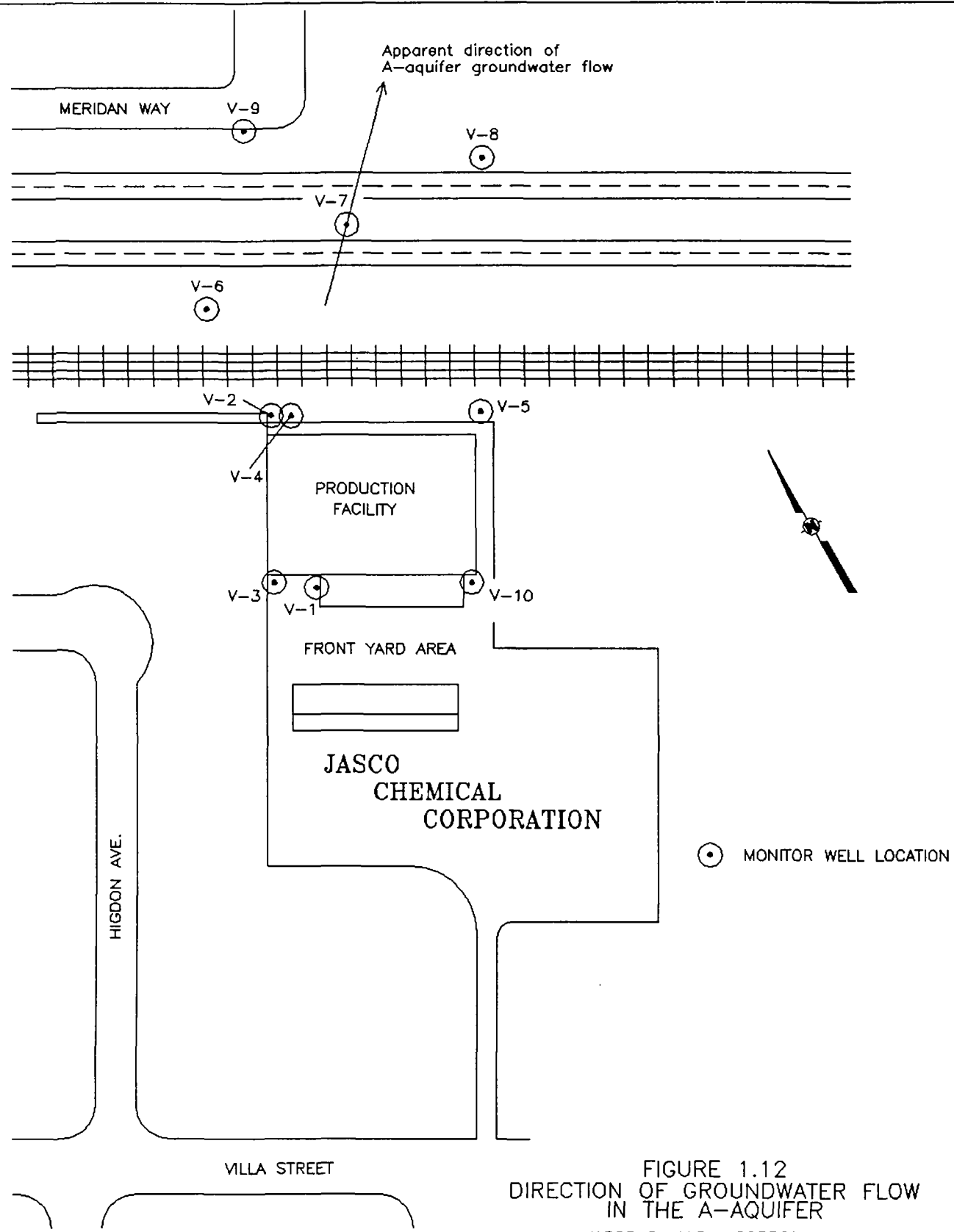
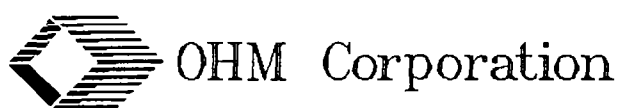


FIGURE 1.12  
 DIRECTION OF GROUNDWATER FLOW  
 IN THE A-AQUIFER

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S. Rice 5-14-92

PLOT SCALE: 1" = 110'

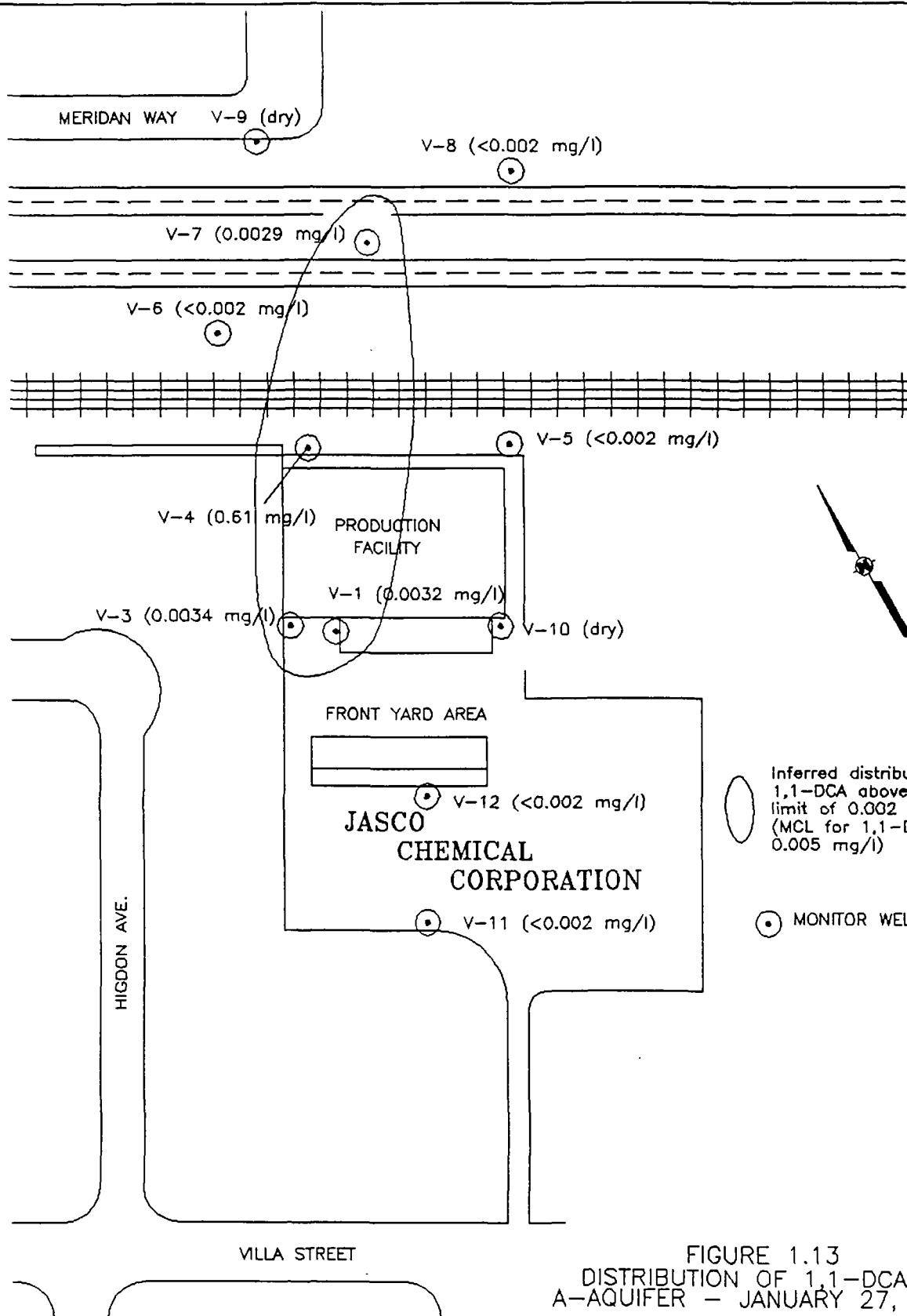


FIGURE 1.13  
DISTRIBUTION OF 1,1-DCA IN  
A-AQUIFER - JANUARY 27, 1992

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PLOT SCALE: 1" = 110'

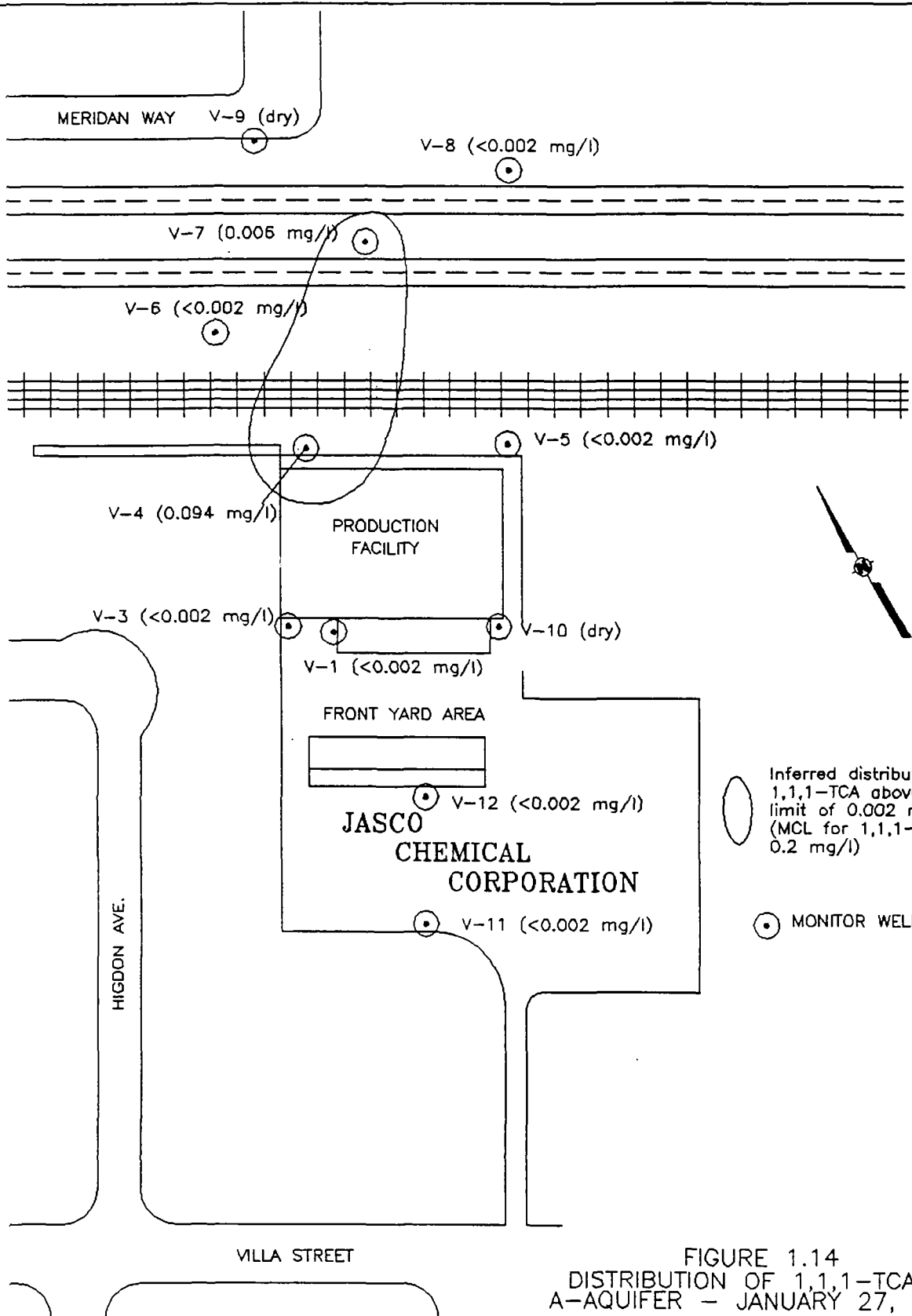
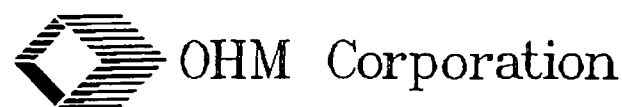


FIGURE 1.14  
DISTRIBUTION OF 1,1,1-TCA IN  
A-AQUIFER - JANUARY 27, 1992

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APPENDIX A  
REFERENCES

## REFERENCES

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## APPENDIX B

### SUMMARY OF RESULTS OF ANALYSES OF GROUNDWATER SAMPLES, 1984 TO 1991



Table B-1  
Summary of Groundwater Analytical Results – Monitor Well V-1 (mg/l)

Constituent	July 1984	Nov 1986	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988	Jan 1989	Sept 1989	Dec 1989
<b>Volatile Organics (EPA methods 601/624)</b>											
1,1,1-Trichloroethane	0.009	na	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	na	na	<0.0005	0.0039	0.004	0.005	0.0066	0.0043	<0.002	0.0037	0.0032
1,1-Dichloroethene	na	na	<0.0005	0.0058	0.0007	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chloroethane	na	na	<0.0005	<0.0005	0.0031	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methylene Chloride	na	0.018	<0.0005	<0.0005	0.0014	0.026	<0.01	<0.01	<0.002	0.014	<0.002
Trans-1,2-DCE	na	na	na	0.0014	0.0016	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
<b>Non-Halogenated Volatile Organics (EPA method 8015)</b>											
Acetone	0.098	na	<1.0	<0.05	0.014	<0.01	0.98	<0.01	<0.01	<0.015	<0.015
Ethanol	<0.02	na	<1.0	<0.05	<0.01	<0.01	0.55	na	<0.01	0.16	<0.05
Isopropanol	<0.030	na	<1.0	<0.05	<0.01	<0.01	0.44	na	<0.01	<0.02	<0.02
Methanol	0.095	na	<1.0	<0.05	<0.01	<0.01	1.4	na	<0.05	0.2	<0.06
Methyl ethyl ketone	0.004	na	<0.0005	<0.0005	<0.001	na	na	na	na	na	na
High Boiling Pt. HC	na	na	<1.0	<1.0	0.36	<0.05	<1.0	<1.0	0.15	0.2	0.3
TPH as paint thinner	0.86	na	<1.0	<1.0	na	na	<1.0	<1.0	na	na	na
<b>Phenols (EPA method 604)</b>											
4-Nitrophenol	na	na	<0.001	<0.01	<0.005	<0.015	<0.05	<0.01	<0.05	<0.02	<0.04
Pentachlorophenol	0.0002	na	<0.001	<0.01	<0.01	<0.01	<0.05	<0.025	<0.05	<0.02	<0.04

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-1 (cont.)  
Summary of Groundwater Analytical Results – Monitor Well V-1 (mg/l)

Constituent	Jan 1990	April 1990	July 1990	Oct 1990	Jan 1991	Jan 1991	April 1991	April(d) 1991	July 1991	July(d) 1991	Nov 1991	Nov(d) 1991
<b>Volatile Organics (EPA methods 601/624)</b>												
1,1,1-Trichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002	<0.005
1,1-Dichloroethane	0.0052	0.0082	0.0056	0.0021	0.0039	<0.005	0.0037	<0.005	na	<0.005	0.0031	<0.005
1,1-Dichloroethene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002	<0.005
Chloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.002	<0.01	na	<0.005	<0.002	<0.005
Methylene Chloride	<0.002	0.0068	0.017	0.0077	0.0058	<0.005	<0.005	<0.005	na	0.0564	<0.005	0.0107
Trans-1,2-DCE	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002	<0.005
<b>Non-Halogenated Volatile Organics (EPA method 8015)</b>												
Acetone	0.038	<0.015	<0.015	<0.015	<0.015	<1.0	<0.05	<1.0	<0.05	<1.0	<0.015	<1.0
Ethanol	<0.05	<0.05	<0.05	<0.05	<0.05	<1.0	<0.05	<1.0	<0.05	<1.0	<0.050	<1.0
Isopropanol	<0.02	<0.02	<0.02	<0.02	<0.02	<1.0	<0.05	<1.0	<0.05	<1.0	<0.020	<1.0
Methanol	<0.06	<0.06	<0.06	<0.06	<0.06	<1.0	<0.25	<1.0	<0.25	<1.0	<0.060	<1.0
Methyl ethyl ketone	na	na	na	na	na	na	na	na	na	na	na	na
High Boiling Pt. HC	1.1	0.97	0.61	<0.05	<0.05	<0.35	0.21	<0.3	0.2	<0.3	0.45	<0.3
TPH as paint thinner	na	na	na	na	<0.05	<0.1	0.12	<0.1	0.25	<0.1	0.16	<0.1
<b>Phenols (EPA method 604)</b>												
4-Nitrophenol	<0.02	0.037	<0.02	<0.02	<0.02	<0.04	<0.002	<0.1	<0.002	na	<0.002	<0.025
Pentachlorophenol	<0.02	0.023	<0.02	<0.02	<0.02	<0.04	<0.01	<0.1	<0.01	na	<0.01	<0.025

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-2  
Summary of Groundwater Analytical Results – Monitor Well V-2 (mg/l)

Constituent	Oct 1986	Nov 1986	Dec 1986	Feb 1987	Mar 1987	Mar 1987	May 1987
Volatile Organics (EPA methods 601/624)							
1,1,1-Trichloroethane	<0.006	na	0.54	2.04	0.61	0.51	0.41
1,1-Dichloroethane	na	na	0.88	<0.50	1.2	0.9	0.54
1,1-Dichloroethene	na	na	<0.005	<0.50	0.11	<0.020	0.051
1,2-Dichloroethane	na	na	<0.005	2.58	<0.005	<0.050	<0.005
trans-1,2-Dichloroethene	na	na	<0.005	<0.50	<0.005	<0.050	<0.005
1,3-Dichlorobenzene	na	na	<0.005	<0.50	<0.005	<0.050	<0.005
Chlorobenzene	na	na	na	<0.50	na	na	na
Chloroethane	na	na	0.17	<0.50	0.08	<0.050	0.006
Dibromochloromethane	na	na	<0.005	<0.50	<0.005	<0.050	<0.005
Methylene Chloride	3.2	142	30	86	1.6	2.4	0.7
Tetrachloroethene	na	na	0.008	<0.50	<0.005	<0.050	<0.005
Trichloroethene	<0.006	na	0.019	<0.50	<0.005	<0.050	0.013
Vinyl Chloride	na	na	<0.005	<0.50	<0.005	<0.050	0.0051
Non-Halogenated Organics (EPA method 8015)							
Acetone	<0.015	na	na	na	na	na	na
Ethanol	na	na	na	na	na	na	na
Isopropanol	na	na	na	na	na	na	na
Methyl ethyl ketone	<0.015	na	na	na	na	na	na
Purgeable Aromatics (EPA method 602)							
Benzene	na	na	na	na	na	na	na
Ethyl Benzene	na	na	na	na	na	na	na
Toluene	na	na	na	na	na	na	na
Xylenes	na	na	na	na	na	na	na
Phenols (EPA method 604)							
Pentachlorophenol	0.0015	na	na	na	na	na	na

na – Analyses not conducted.

(d) – duplicate sample analyses

Note: Monitor well V-2 has been abandoned.

Table B-2 (cont.)  
Summary of Groundwater Analytical Results – Monitor Well V-2 (mg/l)

Constituent	Aug 1987	Aug(d) 1987	Aug(d) 1987	Sept 1987	Oct 1987	Jan 1988	Jan(d) 1988
Volatile Organics (EPA methods 601/624)							
1,1,1-Trichloroethane	0.2	0.25	0.25	0.63	0.5	0.24	0.2
1,1-Dichloroethane	0.63	0.57	0.63	0.49	0.7	0.36	0.25
1,1-Dichloroethene	<0.05	<0.05	<0.05	<0.05	0.076	0.002	0.026
1,2-Dichloroethane	<0.05	<0.05	<0.05	<0.05	na	<0.0005	0.0065
trans-1,2-Dichloroethene	<0.05	<0.05	<0.05	<0.05	na	0.0051	0.0046
1,3-Dichlorobenzene	<0.05	<0.05	<0.05	<0.05	na	0.01	0.025
Chlorobenzene	<0.05	<0.05	<0.05	<0.05	0.037	<0.0005	<0.0005
Chloroethane	<0.05	<0.05	<0.05	<0.05	0.026	0.084	0.18
Dibromochloromethane	<0.05	<0.05	<0.05	<0.05	na	<0.0005	0.0008
Methylene Chloride	1.7	0.2	0.27	0.22	4.6	5.3	6.8
Tetrachloroethene	<0.05	<0.05	<0.05	<0.05	na	<0.0005	0.0006
Trichloroethene	<0.05	<0.05	<0.05	<0.05	na	0.0099	0.012
Vinyl Chloride	<0.05	<0.05	<0.05	<0.05	na	0.0041	0.0072
Non-Halogenated Organics (EPA method 8015)							
Acetone	na	na	<1	0.95	na	na	1.8
Ethanol	na	na	<1	<0.05	na	na	0.026
Isopropanol	na	na	<1	<0.05	na	na	0.092
Methyl ethyl ketone	<0.2	na	<0.05	<0.05	0.027	0.0021	0.014
Purgeable Aromatics (EPA method 602)							
Benzene	0.02	na	<0.05	<0.05	0.007	<0.0005	<0.0005
Ethyl Benzene	<0.010	na	<0.05	<0.05	na	0.0076	0.012
Toluene	0.25	na	<0.05	<0.05	0.2	0.021	0.035
Xylenes	0.05	na	<0.05	0.026	0.044	0.062	0.08
Phenols (EPA method 604)							
Pentachlorophenol	<0.001	na	na	<0.01	na	na	<0.01

na – Analyses not conducted.

(d) – duplicate sample analyses

Note: Monitor well V-2 has been abandoned.

**Table B-3**  
**Summary of Groundwater Analytical Results – Monitor Well V-3 (mg/l)**

Constituent	Nov 1986	Jan 1987	Aug 1987	Sept 1987	Jan 1988	March 1988	Mar(d) 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Dec 1989
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**Volatile Organics (EPA methods 601/624)**

1,1,1-Trichloroethane	<0.0005	<0.0005	0.0018	0.0011	0.0008	<0.002	<0.005	<0.002	<0.002	<0.002	0.0026	0.0022
1,1-Dichloroethane	na	<0.0005	0.015	0.0066	0.008	0.0042	0.007	0.0064	0.003	0.0078	0.008	0.0064
1,1-Dichloroethene	na	<0.0005	0.0013	0.00076	0.0008	<0.002	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-Dichloroethane	na	<0.0005	0.001	<0.0005	<0.0005	<0.002	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002
Methylene Chloride	0.0076	<0.0005	0.0063	0.012	0.0008	<0.002	<0.005	<0.01	<0.01	0.0021	0.29	0.011
Trans-1,2-Dichloroethene	na	0.004	0.012	0.0091	0.004	0.0048	<0.005	0.0021	<0.002	0.0032	0.2	<0.002
Vinyl Chloride	na	<0.0005	<0.0005	0.00068	0.0006	<0.002	<0.010	<0.002	<0.002	<0.002	<0.002	<0.002
Benzene	na	na	<0.0005	<0.0005	<0.005	<0.005	<0.005	<0.002	<0.002	0.011	<0.002	<0.002
Xylenes	na	na	0.008	<0.0005	<0.001	na	<0.005	<0.002	<0.002	0.003	<0.002	<0.002

**Non-Halogenated Volatile Organics (EPA method 8015)**

Acetone	<1.0	<1.0	<1.0	<0.05	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.015	0.036
Ethanol	<1.0	<1.0	<1.0	<0.05	<0.01	<0.01	na	<0.01	na	<0.01	2.7	<0.05
Methanol	0.0027	<0.001	<1.0	<0.05	<0.01	<0.01	na	<0.01	na	<0.01	0.31	<0.06
TPH as Diesel	na	na	na	na	20	<0.05	na	<1.0	5.8	6.2	33	0.92
TPH as Paint Thinner	na	na	<1.0	<1.0	na	<0.05	na	na	na	na	na	na

**Semi-Volatile Organics (EPA method 8270)**

Pentachlorophenol	0.05	<0.001	<0.001	<0.01	<0.01	<0.01	na	<0.01	<0.01	<0.002	<0.002	<0.02
1-[2-(2-Methoxy-1-Methoxy)-1-Methyloxy]-2-Propanol	na	na	na	na	na	na	na	na	na	0.39	na	na
4-Butoxybutanoic Acid	na	na	na	na	na	na	na	na	na	0.049	na	na

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-3 (cont.)  
Summary of Groundwater Analytical Results – Monitor Well V-3 (mg/l)

Constituent	Jan 1990	April 1990	July 1990	Oct 1990	Jan 1991	Jan(d) 1991	Apr 1991	Apr(d) 1991	July 1991	July(d) 1991	Nov 1991
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**Volatile Organics (EPA methods 601/624)**

1,1,1-Trichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	0.0026
1,1-Dichloroethane	0.0047	0.0033	0.0023	<0.002	0.0042	<0.005	0.0034	<0.005	na	<0.005	0.0072
1,1-Dichloroethene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002
1,2-Dichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002
Methylene Chloride	0.014	0.053	0.0064	<0.002	<0.002	<0.005	<0.002	<0.005	na	0.0367	<0.002
Trans-1,2-Dichloroethene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002
Vinyl Chloride	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002
Benzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002
Xylenes	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.005	na	<0.005	<0.002

**Non-Halogenated Volatile Organics (EPA method 8015)**

Acetone	0.02	<0.01	<0.01	<0.01	<0.15	<1.0	<0.05	<1.0	<0.05	<1.0	<0.15
Ethanol	<0.05	<0.05	<0.05	<0.05	<0.15	<1.0	<0.05	<1.0	<0.05	<1.0	<0.15
Methanol	3.8	<0.06	<0.06	<0.06	<0.3	<1.0	<0.25	<1.0	<0.05	<1.0	<0.3
TPH as Diesel	0.25	0.27	0.15	<0.05	<0.05	<0.3	<0.05	<0.3	0.3	<0.3	<0.05
TPH as Paint Thinner	na	na	na	na	<0.05	<0.1	<0.05	<0.1	0.37	<0.1	<0.05

**Semi-Volatile Organics (EPA method 8270)**

Pentachlorophenol	<0.01	<0.01	<0.01	<0.01	<0.011	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01
1-[2-(2-Methoxy-1-Methoxy)-1-Methoxy]-2-Propanol	na	na	na	na	na	na	na	na	na	na	na
4-Butoxybutanoic Acid	na	na	na	na	na	na	na	na	na	na	na

na – Analyses not conducted.

(d) – duplicate sample analyses

**Table B-4**  
**Summary of Groundwater Analytical Results – Monitor Well V-4 (mg/l)**

Constituent	April 1987	May 1987	June 1987	Aug 1987	Sept 25 1987	Sept 27 1987	Jan 1988	Mar 1988	Mar(d) 1988	June 1988	Oct 1988	Oct(d) 1988
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**Volatile Organics (EPA methods 601/624)**

1,1,1-Trichloroethane	1.3	0.39	0.17	0.06	0.03	0.02	0.25	0.14	0.18	0.086	0.054	0.062
1,1-Dichloroethane	2.2	1.2	0.5	0.4	0.31	1.0	0.53	0.36	0.45	0.25	0.23	0.25
1,1-Dichloroethene	0.17	0.14	0.15	0.036	0.014	0.028	0.063	0.06	0.075	0.045	0.042	0.5
1,2-Dichloroethane	<0.01	<0.005	0.0005	<0.005	<0.005	0.008	0.0041	<0.004	<0.01	<0.002	<0.002	<0.005
trans 1,2-Dichloroethen	<0.01	<0.005	0.0066	<0.005	<0.005	na	<0.005	<0.004	<0.01	<0.002	<0.002	<0.005
Bromoform	<0.01	<0.005	0.0005	<0.005	<0.005	na	0.003	<0.004	<0.01	<0.002	<0.002	<0.005
Chlorobenzene	na	na	0.0005	<0.005	<0.005	0.008	<0.005	<0.004	<0.01	<0.002	<0.002	<0.005
Chloroethane	0.16	0.012	0.065	<0.005	0.039	0.059	0.028	0.012	<0.02	0.013	0.016	0.016
Dibromochloromethane	<0.01	<0.005	0.0005	<0.005	<0.005	na	0.0026	<0.004	<0.01	<0.002	<0.002	<0.005
Methylene Chloride	1.4	0.49	0.11	<0.005	<0.005	0.003	0.21	0.031	<0.01	<0.01	<0.01	0.007
Toluene	na	na	0.0038	<0.005	<0.005	0.017	0.014	<0.004	<0.01	<0.002	<0.002	<0.005
Vinyl Chloride	0.011	<0.005	0.016	<0.005	<0.005	na	0.01	<0.004	<0.02	<0.002	<0.002	<0.01

**Non-Halogenated Volatile Organics (EPA method 8015)**

Acetone	na	na	na	<1.0	<0.05	na	0.018	<0.05	<0.04	<0.01	<0.01	na
Ethanol	na	na	na	<1.0	<0.05	na	<0.01	<0.01	na	<0.01	na	na
Isopropanol	na	na	na	<1.0	<0.05	na	<0.01	<0.01	na	<0.01	na	na
Methanol	na	na	na	<1.0	<0.05	na	<0.01	<0.01	na	<0.01	na	na
TPH as diesel	na	na	na	<1.0	<1.0	na	2.2	<0.05	na	<1.0	<1.0	na
TPH as paint thinner	na	na	na	na	na	na	na	na	na	na	na	na

**Phenols (EPA method 604)**

Phenol	na	na	na	<0.001	<0.01	na	<0.01	<0.01	na	<0.002	0.0032	na
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na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-4 (cont.)  
Summary of Groundwater Analytical Results – Monitor Well V-4 (mg/l)

Constituent	Jan 1989	Jan(d) 1989	Jan(d) 1989	Aug 1989	Dec 1989	Jan 1990	Jan(d) 1990	April 1990	July 1990	Oct 1990
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Volatile Organics (EPA methods 601/624)

1,1,1-Trichloroethane	0.99	0.97	1.4	0.069	1.7	0.14	0.129	0.041	0.048	0.042
1,1-Dichloroethane	0.68	0.69	0.85	0.27	7.8	0.29	0.328	0.23	0.24	0.14
1,1-Dichloroethene	0.066	0.066	0.079	0.033	0.19	0.029	0.0262	0.021	0.038	<0.005
1,2-Dichloroethane	<0.002	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
trans 1,2-Dichloroethen	<0.02	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
Bromoform	<0.02	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
Chlorobenzene	<0.02	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
Chloroethane	<0.02	<0.02	<0.1	0.013	0.39	0.0066	<0.01	0.0061	0.012	<0.005
Dibromochloromethane	<0.02	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
Methylene Chloride	0.55	0.54	0.64	<0.002	3.5	0.015	0.0128	0.005	<0.002	<0.005
Toluene	<0.02	<0.02	<0.05	<0.002	<0.1	<0.004	<0.005	<0.004	<0.002	<0.005
Vinyl Chloride	<0.02	<0.02	<0.1	0.0026	<0.1	0.0054	<0.01	0.0053	0.005	<0.005

Non-Halogenated Volatile Organics (EPA method 8015)

Acetone	<0.01	na	na	<0.01	1.7	0.1	<0.01	<0.01	<0.01	<0.01
Ethanol	na	na	na	<0.05	16	0.2	<1.0	<0.05	<0.05	<0.05
Isopropanol	na	na	na	<0.06	1.4	<0.02	<1.0	<0.02	<0.02	<0.02
Methanol	na	na	na	0.73	0.17	<0.06	<10	<0.06	<0.06	<0.06
TPH as diesel	0.27	na	na	0.082	2.1	0.12	0.3	0.24	0.35	<0.05
TPH as paint thinner	na	na	na	na	na	na	na	na	na	na

Phenols (EPA method 604)

Phenol	<0.002	na	na	<0.002	<0.004	<0.002	<0.05	<0.002	<0.002	<0.002
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na – Analyses not conducted.

(d) – duplicate sample analyses



Table B-4 (cont.)  
Summary of Groundwater Analytical Results – Monitor Well V-4 (mg/l)

Constituent	Jan 1991	Jan(d) 1991	April 1991	April(d) 1991	July 1991	July(d) 1991	Nov 1991	Nov(d) 1991
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Volatile Organics (EPA methods 601/624)

1,1,1-Trichloroethane	0.028	0.0236	0.07	0.0719	na	0.0461	0.094	0.0841
1,1-Dichloroethane	0.26	0.226	0.31	0.382	na	0.329	0.65	0.427
1,1-Dichloroethene	0.014	0.0111	0.038	0.0379	na	0.0254	0.027	0.0228
1,2-Dichloroethane	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
trans 1,2-Dichloroethen	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
Bromoform	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
Chlorobenzene	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
Chloroethane	0.023	0.0239	0.0074	0.0108	na	<0.005	0.011	0.0591
Dibromochloromethane	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
Methylene Chloride	<0.004	<0.005	<0.005	<0.005	na	0.0054	0.15	0.093
Toluene	<0.004	<0.005	<0.005	<0.005	na	<0.005	<0.01	<0.005
Vinyl Chloride	<0.004	<0.01	0.0064	<0.01	na	<0.005	<0.01	<0.005

Non-Halogenated Volatile Organics (EPA method 8015)

Acetone	<0.15	<1.0	<0.050	<1.0	<0.050	<1.0	<0.015	<1.0
Ethanol	<0.15	<1.0	<0.050	<1.0	<0.050	<1.0	<0.050	<1.0
Isopropanol	<0.15	<1.0	<0.050	<1.0	<0.050	<1.0	<0.020	<1.0
Methanol	<0.3	<1.0	<0.25	<1.0	<0.25	<1.0	<0.060	<1.0
TPH as diesel	<0.05	<0.6	0.16	<0.3	0.51	na	0.34	<0.3
TPH as paint thinner	<0.05	<0.1	0.094	<0.1	0.62	<0.1	0.13	<0.1

Phenols (EPA method 604)

Phenol	<0.002	<0.03	<0.002	<0.1	<0.002	na	<0.002	<0.025
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na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-5  
Summary of Groundwater Analytical Results – Monitor Well V-5 (mg/l)

Constituent	May(1) 1987	June(2) 1987	Aug(1) 1987	Sept(1) 1987	Jan(1) 1988	March(1) 1988	June(1) 1988	June(2) 1988	Oct(2) 1988
Non-Halogenated Volatile Organics (EPA method 8015)									
Acetone	<1.0	na	<1.0	<0.05	<0.01	<0.01	0.12	<0.01	<0.01

Constituent	Jan(3) 1989	Aug(2) 1989	Jan(2) 1990	July(2) 1990	Jan(2) 1991	July(1) 1991	Nov(1) 1991
Non-Halogenated Volatile Organics (EPA method 8015)							
Acetone	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01

na – Analyses not conducted

(1) – Analyses by modified EPA method 8015

(2) – Analyses by EPA method 8240

(3) – Analyses by both mod. EPA 8015 and EPA 8240

Table B-6  
Summary of Groundwater Analytical Results – Monitor Well V-6 (mg/l)

Constituent	May 1987	June 1987	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988
Volatile Organics (EPA methods 601/624)								
1,1,1-Trichloroethane	<0.0038	<0.0005	0.0025	0.0045	0.0026	0.0032	<0.002	<0.002
Benzene	<0.0044	<0.0005	<0.0005	0.0019	<0.0005	<0.002	<0.002	<0.002

Constituent	Jan 1989	Aug 1989	Jan 1990	July 1990	Jan 1991	July 1991	Nov 1991
Volatile Organics (EPA methods 601/624)							
1,1,1-Trichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Benzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

na – Analyses not conducted

Table B-7  
Summary of Groundwater Analytical Results – Monitor Well V-7 (mg/l)

Constituent	May 1987	June 1987	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988	Oct(d) 1988	Jan 1989	Jan(d) 1989
Volatile Organics (EPA methods 601/624)											
1,1,1-Trichloroethane	0.064	0.028	0.016	0.023	0.012	0.018	0.013	0.031	0.036	0.0074	0.0087
1,1-Dichloroethane	0.055	0.049	0.024	0.019	0.014	0.029	0.028	0.01	0.012	0.012	0.016
1,1-Dichloroethene	0.0077	<0.0002	0.0019	0.0024	0.0035	0.0081	0.006	0.0029	<0.005	0.0032	0.0043
Acetone	<1.0	na	<1.0	<0.050	<0.01	<0.01	<0.01	<0.01	<0.02	na	<0.01
Carbon Tetrachloride	0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.002	<0.002	<0.002	<0.005	<0.001	<0.002
Chloroform	<0.0016	<0.0005	<0.0005	<0.0005	0.0007	<0.01	<0.01	<0.01	<0.005	<0.0005	<0.002
Methylene Chloride	<0.0028	<0.0005	<0.0005	<0.0005	<0.0005	<0.01	<0.01	<0.01	<0.005	<0.002	<0.002
Vinyl Chloride	<0.005	<0.0005	<0.0005	<0.0005	0.0012	<0.002	<0.002	<0.002	<0.01	<0.002	<0.002

Constituent	Jan(d) 1989	Aug 1989	Dec 1989	Jan 1990	April 1990	July 1990	Oct 1990	Jan 1991	April 1991	July 1991	Nov 1991
Volatile Organics (EPA methods 601/624)											
1,1,1-Trichloroethane	0.012	0.0067	<0.002	0.0033	0.0043	0.0034	0.0064	0.0078	0.0035	na	0.0038
1,1-Dichloroethane	0.02	0.012	0.005	0.015	0.013	0.0075	0.0094	0.03	0.012	na	0.015
1,1-Dichloroethene	0.007	0.0033	<0.002	0.0034	0.0037	0.0032	<0.002	0.0075	0.0042	na	0.0031
Acetone	<0.01	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	na	<0.01
Carbon Tetrachloride	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	na	<0.002
Chloroform	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	na	<0.002
Methylene Chloride	<0.002	0.0048	0.0048	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	na	<0.002
Vinyl Chloride	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	na	<0.002

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-8  
Summary of Groundwater Analytical Results – Monitor Well V-8 (mg/l)

Constituent	Mar 8 1988	Mar 22 1988	Mar(d) 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Dec 1989	Jan 1990	April 1990	July 1990
<b>Volatile Organics (EPA method 601/624)</b>											
1,1,1-Trichloroethane	0.0035	0.0037	0.007	0.0026	0.0024	0.004	0.0028	0.0025	0.0026	0.0026	0.0031
1,1-Dichloroethane	<0.002	0.00069	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethene	<0.002	0.00065	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2-Propanone	0.003	na	na	na	na	na	na	na	na	na	na
Acetone	<0.010	<0.010	<0.020	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Constituent	Oct 1990	Jan 1991	April 1991	July 1991	Nov 1991
<b>Volatile Organics (EPA method 601/624)</b>					
1,1,1-Trichloroethane	0.002	0.0021	<0.002	na	<0.002
1,1-Dichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethene	<0.002	<0.002	<0.002	<0.002	<0.002
2-Propanone	na	na	na	na	na
Acetone	<0.010	<0.010	<0.010	<0.010	0.033

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-9  
Summary of Groundwater Analytical Results – Monitor Well V-9 (mg/l)

Constituent	Mar 8 1988	Mar 22 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Dec 1989	Jan 1990
Volatile Organics (EPA methods 601/624)								
1,1,1-Trichloroethane	<0.002	0.0022	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,1-Dichloroethane	0.0036	0.0039	0.0031	0.0039	0.0028	0.0027	0.0029	0.0028
2-Propanone	0.0051	na	na	na	na	na	na	na
Toluene	<0.002	<0.0005	<0.002	<0.002	<0.002	<0.002	0.0023	<0.002
Non Halogenated Volatile Organics (EPA Method 8015)								
Methanol	<0.01	na	0.54	na	na	<0.06	<0.06	<0.06

na – Analyses not conducted.

Constituent	April 1990	July 1990	Oct 1990*	Jan 1991*	April 1991*	July 1991*	Nov 1991*
Volatile Organics (EPA methods 601/624)							
1,1,1-Trichloroethane	<0.002	<0.002	na	na	na	na	na
1,1-Dichloroethane	0.0026	0.0026	na	na	na	na	na
2-Propanone	na	na	na	na	na	na	na
Toluene	<0.002	<0.002	na	na	na	na	na
Non Halogenated Volatile Organics (EPA Method 8015)							
Methanol	<0.06	<0.06	na	na	na	na	na

na – Analyses not conducted.

\* – well dry; no sample collected

Table B-10  
Summary of Groundwater Analytical Results – Monitor Well V-10 (mg/l)

Constituent	Mar 9 1988	Mar 9(d) 1988	Mar 22 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Dec 1989	Jan 1990	April 1990
<b>Volatile Organics (EPA methods 601/624)</b>										
1,1,1-Trichloroethane	<0.002	<0.005	0.00096	<0.002	<0.002	<0.02	<0.002	<0.002	<0.002	<0.002
Methylene Chloride	<0.01	<0.005	<0.0005	<0.01	<0.01	2.0	<0.002	<0.002	0.003	0.0039
<b>Non-Halogenated Volatile Organics (EPA method 8015)</b>										
Acetone	<0.01	<0.02	na	1.3	0.023	<0.01	<0.015	<0.01	<0.01	<0.01
Ethanol	<0.01	na	na	0.17	na	<0.01	<0.05	<0.05	<0.05	<0.05
Isopropanol	<0.01	na	na	0.33	na	<0.01	<0.02	<0.02	<0.02	<0.02

Constituent	July 1990	Oct 1990	Jan 1991*	April 1991*	July 1991*	Nov 1991*
<b>Volatile Organics (EPA methods 601/624)</b>						
1,1,1-Trichloroethane	<0.002	<0.002	na	na	na	na
Methylene Chloride	<0.002	<0.002	na	na	na	na
<b>Non-Halogenated Volatile Organics (EPA method 8015)</b>						
Acetone	<0.01	<0.01	na	na	na	na
Ethanol	<0.05	<0.05	na	na	na	na
Isopropanol	<0.02	<0.02	na	na	na	na

na – Analyses not conducted.

(d) – duplicate sample analyses

\* – well dry; no sample collected

**Table B-11**  
**Summary of Groundwater Analytical Results – Monitor Well V-11 (mg/l)**

Constituent	June 1990	Oct 1990	Jan 1991	April 1991	July 1991	Nov 1991
No target constituents were detected exceeding the minimum detection limit						

**Table B-12**  
**Summary of Groundwater Analytical Results – Monitor Well V-12 (mg/l)**

Constituent	June 1990	Oct 1990	Jan 1991	April 1991	July 1991	Nov 1991
No target constituents were detected exceeding the minimum detection limit						



Table B-13  
Summary of Groundwater Analytical Results – Monitor Well I-1 (mg/l)

Constituent	May 1987	June 3 1987	June 22 1987	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988	Jan 1989	Aug 1989
Volatile Organics (EPA methods 601/624)											
1,1,1-Trichloroethane	<0.0038	<0.005	<0.005	0.0019	0.002	0.0021	<0.002	<0.002	0.0021	<0.002	<0.002
1,1-Dichloroethane	0.011	0.0039	<0.005	0.0023	0.003	0.0012	0.0029	<0.002	<0.002	0.0026	0.002
Acetone	na	na	na	<1.0	<0.05	<0.01	<0.01	0.13	0.024	<0.01	<0.015
Methylene Chloride	<0.0028	<0.005	0.032	<0.0005	<0.0005	<0.0005	<0.01	<0.01	<0.01	<0.01	<0.002

Constituent	Dec 1989	Jan 1990	April 1990	July 1990	Oct 1990	Jan 1991	April 1991	Apr(d) 1991	July 1991	Nov 1991	Nov(d) 1991
Volatile Organics (EPA methods 601/624)											
1,1,1-Trichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	na	<0.002	<0.005
1,1-Dichloroethane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	na	<0.002	<0.005
Acetone	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	na	<0.01	<0.01
Methylene Chloride	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	na	<0.002	0.008

na – Analyses not conducted.

(d) – duplicate sample analyses

Table B-14  
Summary of Groundwater Analytical Results – Monitor Well I-2 (mg/l)

Constituent	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Dec 1989	Jan 1990
Volatile Organics (EPA methods 601/624)										
1,1,1-Trichloroethane	0.0068	<0.0005	0.0032	0.003	0.0039	0.0033	0.0028	0.0027	0.0036	0.0032
1,1-Dichloroethane	0.014	<0.0005	0.01	0.0045	0.0051	0.0037	0.0036	0.0035	0.0046	0.0029
1,1-Dichloroethene	0.0071	<0.0005	0.003	0.0024	0.0029	<0.002	0.0021	0.0023	0.0026	<0.002
Acetone	na	<0.05	<0.01	<0.01	<0.01	0.019	<0.01	<0.015	<0.01	<0.01

Constituent	April 1990	July 1990	Oct 1990	Jan 1991	April 1991	July 1991	Nov 1991
Volatile Organics (EPA methods 601/624)							
1,1,1-Trichloroethane	0.0022	0.003	<0.002	0.0024	<0.002	na	0.0031
1,1-Dichloroethane	0.0025	0.003	<0.002	0.0023	<0.002	na	0.0027
1,1-Dichloroethene	<0.002	0.0022	<0.002	<0.002	<0.002	na	<0.002
Acetone	<0.01	<0.01	<0.01	<0.01	<0.01	na	<0.01

na – Analyses not conducted.

Table B-15  
Summary of Groundwater Analytical Results – Monitor Well I-3 (mg/l)

Constituent	Aug 1987	Sept 1987	Jan 1988	March 1988	June 1988	Oct 1988	Jan 1989	Aug 1989	Jan 1990
Volatile Organics (EPA methods 601/624)									
Vinyl Chloride	<0.0005	<0.0005	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phenols (EPA method 8040)									
Phenol	na	0.02	<0.01	<0.01	<0.002	<0.003	<0.002	<0.002	<0.002

Constituent	July 1990	Jan 1991	July 1991	Nov 1991
Volatile Organics (EPA methods 601/624)				
Vinyl Chloride	<0.002	<0.002	na	<0.002
Phenols (EPA method 8040)				
Phenol	0.0036	<0.002	<0.002	<0.002

na – analyses not conducted

APPENDIX C  
ENDANGERMENT ASSESSMENT

ENVIRONMENTAL PROTECTION AGENCY  
TECHNICAL ENFORCEMENT SUPPORT  
AT  
HAZARDOUS WASTE SITES

TES IV  
CONTRACT NO. 68-01-7351  
WORK ASSIGNMENT NO. C09008  
ENDANGERMENT ASSESSMENT  
FOR  
JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CA  
EPA REGION IX  
SITE ACCOUNT NUMBER: 9BF6

JACOBS ENGINEERING GROUP INC.

PROJECT NUMBER 05-B810-00

AUGUST 1989

## TABLE OF CONTENTS

	<u>PAGE</u>
List of Tables	iv
List of Figures	v
 EXECUTIVE SUMMARY	 1
 1.0 INTRODUCTION	 3
 2.0 SITE CHARACTERIZATION	 4
2.1 Site History and Description	4
2.2 Process Description	4
2.2.1 Waste Management Practices	7
2.3 Environmental Setting	8
2.3.1 Hydrology	8
2.3.2 Local Geology	8
2.3.3 Local Hydrogeology	10
2.3.4 Climatology	11
2.4 Remedial Activities	12
 3.0 INDICATOR CONTAMINANT SELECTION	 17
3.1 Introduction	17
3.2 Indicator Contaminant Selection Methodology	17
3.3 Health Effects of Indicator Contaminants	18
 4.0 EXPOSURE ASSESSMENT	 24
4.1 Introduction	24
4.2 Study Area Characterization	24
4.3 Potential Exposure Media	25
4.3.1 Ground Water Exposure Media	25
4.3.2 Surface Water Exposure Media	32
4.3.3 Air and Soil Exposure Media	33

	<u>PAGE</u>
4.4 Potential Exposure Pathways	33
4.4.1 Current Land-Use	33
4.4.2 Future Land-Use	35
4.4.3 Conclusion	38
4.5 Exposure Point Concentrations	38
4.5.1 Exposure Point Concentration Determination Methodology	39
4.6 Comparison to Applicable or Relevant and Appropriate Requirements (ARARs)	42
4.6.1 ARARs for Ground water	44
4.6.2 ARARs for Air	44
4.6.3 ARARs for Soils	48
4.6.4 Results of Comparison	48
 5.0 HUMAN INTAKE ASSESSMENT	 51
5.1 Introduction	51
5.2 Intake Calculation Assumptions	51
5.2.1 Water Ingestion	53
5.2.2 Soil Ingestion	53
5.2.3 Particulate Inhalation	54
5.2.4 Inhalation of Vapor While Showering	55
5.2.5 Dermal Exposure to Soils	55
5.2.6 Dermal Exposure to Water	56
5.2.7 Inhalation of Vapors Outside of Residence	56
5.3 Intake Analysis	56
 6.0 RISK CHARACTERIZATION	 57
6.1 Introduction	57
6.2 Non-Carcinogenic Risk Assessment Methodology and Results	57
6.3 Carcinogenic Risk Assessment Methodology and Results	58
6.4 Risk Analysis	61
6.4.1 Ground Water	61
6.4.2 Soils	62
6.4.3 Conclusions	63
 7.0 CONCLUSION	 65
8.0 REFERENCES	

## APPENDIX A

1. Regional Geology
2. Regional Hydrogeology
3. Chemical Analysis Results
4. Distribution of Chemicals Detected in Soil and Ground Water

## APPENDIX B

1. Indicator Contaminant Selection Worksheets and Tables

## APPENDIX C

1. Summary of Ground Water Modeling

## APPENDIX D

1. Screening Analysis for Air Emissions
2. Potential Chronic and Subchronic Daily Intake Tables

## APPENDIX E

1. Hazard Indices and Potential Cancer Risks Tables



## LIST OF TABLES

	<u>PAGE</u>
Table 2-1	Summary of Contaminants Detected in Ground Water 13
Table 2-2	Summary of Contaminants Detected in Surface Water 14
Table 2-3	Summary of Contaminants Detected in Soils 15
Table 3-1	Final Indicator Contaminant List 19
Table 4-1	Potential Pathways of Exposure to Contaminants Originating at the Jasco Site Under Current Land-Use Conditions 34
Table 4-2	Potential Pathways of Exposure to Contaminants Originating at the Jasco Site Under Potential Future Land-Use Conditions 36
Table 4-3	Exposure Point Concentrations (Ground Water) 40
Table 4-4	Exposure Point Concentrations (Soils) 41
Table 4-5	Exposure Point Concentrations (Air) 43
Table 4-6	Potential ARARs and Other Criteria for Contaminants in Ground Water 45
Table 4-7	EPA Drinking Water Health Advisors 46
Table 4-8	Air-Standards (Non-ARARs) 47
Table 4-9	Soil Standards (Non-ARARs) 49
Table 4-10	Exposure Point Concentrations vs. Potential ARARs or Other Criteria for Contaminants in Ground Water 50
Table 6-1	Acceptable Daily Intake for Indicator Contaminants (Non-Carcinogenic) 59
Table 6-2	Carcinogenic Potency Factors for Indicator Contaminants (Carcinogens) 60

## LIST OF FIGURES

		<u>PAGE</u>
Figure 2-1	Site Location: Jasco Chemical Corp. Site	5
Figure 2-2	Site Configuration	6
Figure 2-3	Surface Drainage Control System and Extent of Bermed Areas	9
Figure 4-1	Jasco Endangerment Assessment Study Area	25
Figure 4-2	Conduit Inventory Region	28
Figure 4-3	Preliminary Well Identification Summary	29

## EXECUTIVE SUMMARY

This Endangerment Assessment represents the public health evaluation associated with the Jasco Chemical Corporation site, located in the City of Mountain View, California. Exposure pathways were defined to illustrate the potential effects upon human receptors and estimates of the risks associated with these pathways were determined.

The guidance documents used for this assessment were the U.S. EPA Superfund Public Health Evaluation Manual and Exposure Assessment Manual. The Endangerment Assessment was completed using the following procedures:

- 1) Analyzing high probability and low probability exposure scenarios at or near the site which would be expected to occur in the absence of remedial measures.
- 2) Estimating the likely range of contaminants concentrations to which individuals who participate in the exposure scenarios may be exposed.
- 3) Determining best estimate and maximum plausible values for human intake of contaminants from exposure scenarios developed for the site.
- 4) Characterizing the health effects and health risks to which individuals who are involved in the exposure scenarios may be subjected.

The criteria used to differentiate between risk levels of concern and those that are less significant were the following:

- 1) A non-carcinogenic risk was considered significant when a chemical intake equaled or exceeded its acceptable chronic or subchronic intake value.
- 2) A "one in a million" risk or one excess cancer risk in a population of  $10^6$  after a 70-year exposure period was considered significant in determining carcinogenic risks.

(These criteria were used to characterize and differentiate risks estimated in this Endangerment Assessment only, and should not be considered as the only criteria by which to judge and evaluate any future remediation efforts at the Jasco site.)

Under current land-use conditions of the site the only complete exposure pathway was associated with inhalation of volatilized contaminants originating from the soils. A screening analysis was conducted and it was determined that the potential cancer risk associated with inhalation of volatilized contaminants was  $5.8 \times 10^{-7}$ . This risk is within the  $10^{-4}$  to  $10^{-7}$  range which is considered by USEPA to be protective of human health after remediation.

Potential carcinogenic and non-carcinogenic risks were calculated for each of the exposure scenarios associated with potential future land-use conditions (residential occupancy). The risk calculations were made for representative contaminant concentrations (best estimate) and highest measured contaminant concentrations (maximum plausible). As a result each scenario is associated with four risk calculations; best estimate - carcinogenic; best estimate - non-carcinogenic; maximum plausible - carcinogenic and maximum plausible - non-carcinogenic. Results of the findings are as follows:

- 1) Significant carcinogenic risks were calculated for private well water (A-aquifer) consumption and inhalation of vapors originating from contaminated ground water. Potential excess lifetime cancer risk were determined to be  $3.6 \times 10^{-3}$  (best estimate) and  $4.0 \times 10^{-3}$  (maximum plausible) for ground water ingestion, and  $2.7 \times 10^{-4}$  (best estimate) and  $5.9 \times 10^{-4}$  (maximum plausible) for vapor inhalation.
- 2) Significant non-carcinogenic risks were calculated for ground water ingestion using representative and highest measured contaminant concentrations.
- 3) Potential carcinogenic and non-carcinogenic risks associated with exposure to on-site contaminated soils via incidental ingestion or fugitive dust inhalation were not significant.

The Endangerment Assessment has demonstrated that contaminants detected at the Jasco site pose no threat to public health under current land-use conditions. However potential future land-use scenarios are described which could pose higher health risks. The assessment identifies pathways that might be impacted by remedial activity and can be used to facilitate the selection of remedial action alternatives.

## SECTION 1.0

### INTRODUCTION

The remedial investigation conducted at the Jasco Chemical Corporation (Jasco) site has characterized the impacts of the site on the quality of ground water, surface water and soils. This Endangerment Assessment is a basis for evaluating whether or not corrective action is necessary at the site and defines goals for corrective action. The evaluation considers the nature of chemical releases from the site, the potential pathways for human and environmental exposure to the releases, and the degree to which the concentration at the point of exposure exceeds existing standards or acceptable criteria.

The purpose of the Endangerment Assessment is to evaluate the impact to public health that may result from releases from the Jasco site. The assessment considers risks based on current exposure pathways and potential risks that may result from future exposure pathways if no action is taken. A human exposure pathway consists of four elements: a source and mechanism of chemical release, an environmental transport medium such as air or ground water, a point of potential human contact with the medium and a human exposure route such as inhalation of air or ingestion of ground water at the contact point. All four elements must be present to complete a pathway. For the Jasco site, both a current exposure pathway and potential future exposure pathways are evaluated assuming a no remediation scenario.

The baseline evaluation for the Jasco site considers four areas of study: ground water quality, surface water quality, soils and air quality. The objective of the assessment is to characterize the following for each study area:

- o The potential for a release from the site.
- o The toxicity, quantity, transport and fate of the substance in each media (ground water, surface water, soils and air).
- o The presence of an exposure pathway.
- o The likelihood of an impact on public health.

This Endangerment Assessment is divided into the Site Characterization (Section 2.0), Selection of Indicator Contaminants (Section 3.0), Exposure Assessment (Section 4.0), Human Intake Assessment (Section 5.0) and a characterization of the overall risk for each exposure scenario (Section 6.0). The detailed tables, figures and worksheets used in the Endangerment Assessment are contained in Appendix A through E. Summary tables are presented in the text.

## SECTION 2.0

### SITE CHARACTERIZATION

Information presented in this Section was obtained from various reports prepared for Jasco by Wahler Associates. Information obtained from other sources is referenced accordingly. Detailed figures and tables documenting this section are presented in Appendix A.

#### 2.1 Site History and Description

Jasco is located at 1710 Villa Street in Mountain View, California (see Figure 2-1). Jasco has been in operation at this address, repackaging bulk chemicals into small containers and blending chemicals to produce proprietary products, since December 1976. The Jasco site encompasses 2.05 acres and is bordered on the northeast by Central Expressway and Southern Pacific Railroad, main line right-of-way and the Villa Mariposa apartment complex on the east. Single and multi-family dwellings along Higdon Avenue and Villa Street border the Jasco site to the west and south. Access to the site is gained from the south by way of Villa Street.

The site has historically been zoned industrial but was rezoned in December 1983 as residential. The property immediately southeast was previously occupied by Pacific Press and Peninsula Tube Bending. Prior to Jasco, the site was occupied by West Coast Doors, Inc.. West Coast Doors, Inc. used the site from May 1954 to June 1975 to manufacture and paint commercial and residential doors. The site was vacant from June 1975 to November 1976.

The actual plant, offices and storage areas are located at the rear of the property and occupy approximately 31,000 square feet of the total 89,300 square feet (2.05 acres). Approximately 66 percent of the site is vacant land. The facility is a combination of tilt-up concrete production area with a built-up roof. The production area is 4,000 ft<sup>2</sup> and completely explosion-proof wired and heavy-duty sprinklered. The finished goods area is 12,000 ft<sup>2</sup> and of butler-type construction with heavy-duty sprinklers and in-rack sprinklers for storage of flammable finished goods. Figure 2-2 presents the configuration of the Jasco site and layout of the facility.

#### 2.2 Process Description

Jasco's production process involves repackaging of bulk chemicals into small containers and blending of chemicals to produce proprietary products. Bulk solvents are received in tankers and stored in eight underground tanks as shown in Figure 2-3. Filling of the underground tanks is done by gravity. Tanks

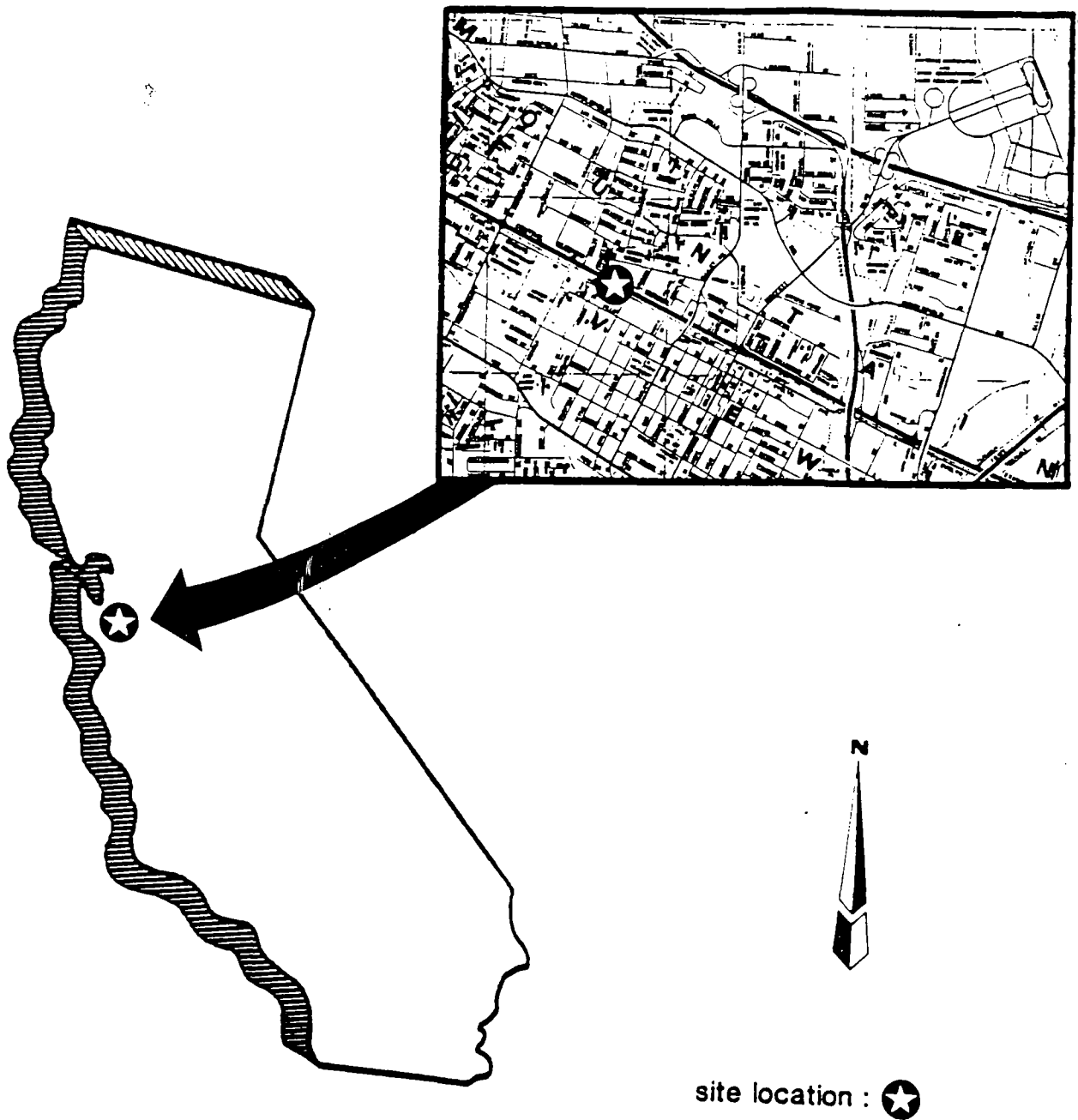
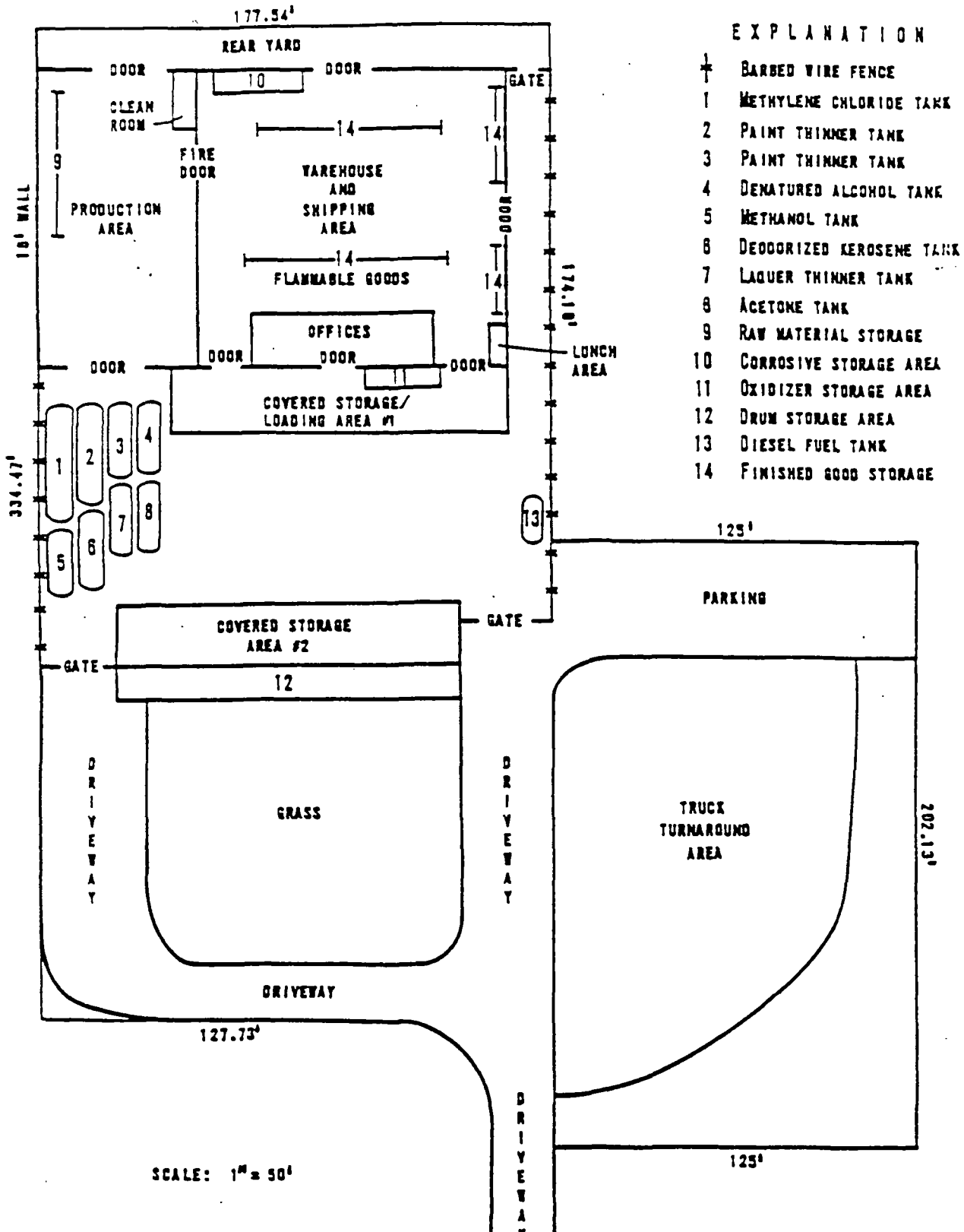


Figure 2-1 : Site Location - Jasco Chemical Corp. Site  
Mountain View, CA.

SOUTHERN PACIFIC RAILROAD



JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA



JACOBS ENGINEERING GROUP INC.

SITE CONFIGURATION

Source: Wahler Assoc.

FIGURE

2-2



are checked with a dip stick at least twice a week and is the basis for reordering additional solvents (Wahler Associates, Site Inspection Report, June 1987).

The physical characteristics of the loading and unloading areas are a combination of asphalt and concrete. Putty mixer, filling machine and all above-ground tanks are located in an area that has a reinforced concrete floor with the entire perimeter bermed so as to contain any uncontrolled release (Wahler Associates, Site Inspection Report, June 1987). Figure 2-3 also presents the locations of the bermed area, drains, drainage piping, dry wells, and the on-site sump.

#### 2.2.1 Waste Management Practices

Prior to 1983, South Bay Chemical Co., and IT Transportation were used as the waste hauling companies. Manifest records are available only from 1980 to 1983. In 1983 production piping was altered in order to segregate compatible solvents. This allowed Jasco to accumulate line washings for reuse and eliminated the generation of waste (Wahler Associates, Site Inspection Report, June 1987).

In February 1987, a 55-gallon plastic drum containing methylene chloride was spilled on the concrete portion of the loading area. The spill was reported, and cleaned up by the use of an absorbant within 10 minutes. The spill site was inspected by the City of Mountain View Fire Department, Hazardous Chemical Section, and determined that none of the material had escaped from the site. No other spills of "clean" or waste product are known to have occurred (Wahler Associates, Site Inspection Report, June 1987). There are no known areas at the Jasco site that were or are used to dispose of any material.

## 2.3 Environmental Setting

The Jasco site is located in the San Francisco Bay area, in a major structural depression situated between the Santa Cruz Mountains on the west and the Hayward-Calaveras fault systems on the east. Locally, the site is bounded on the west by the Santa Cruz Mountains and the Berkeley Hills and Diablo Range on the north and east.

The Jasco site is located on a gently sloping alluvial plain which terminates at San Francisco Bay, approximately 4.5 miles to the north. Permanente Creek, a northward flowing, concrete-lined and channelized stream is located approximately 600 feet to the west-northwest of the site.

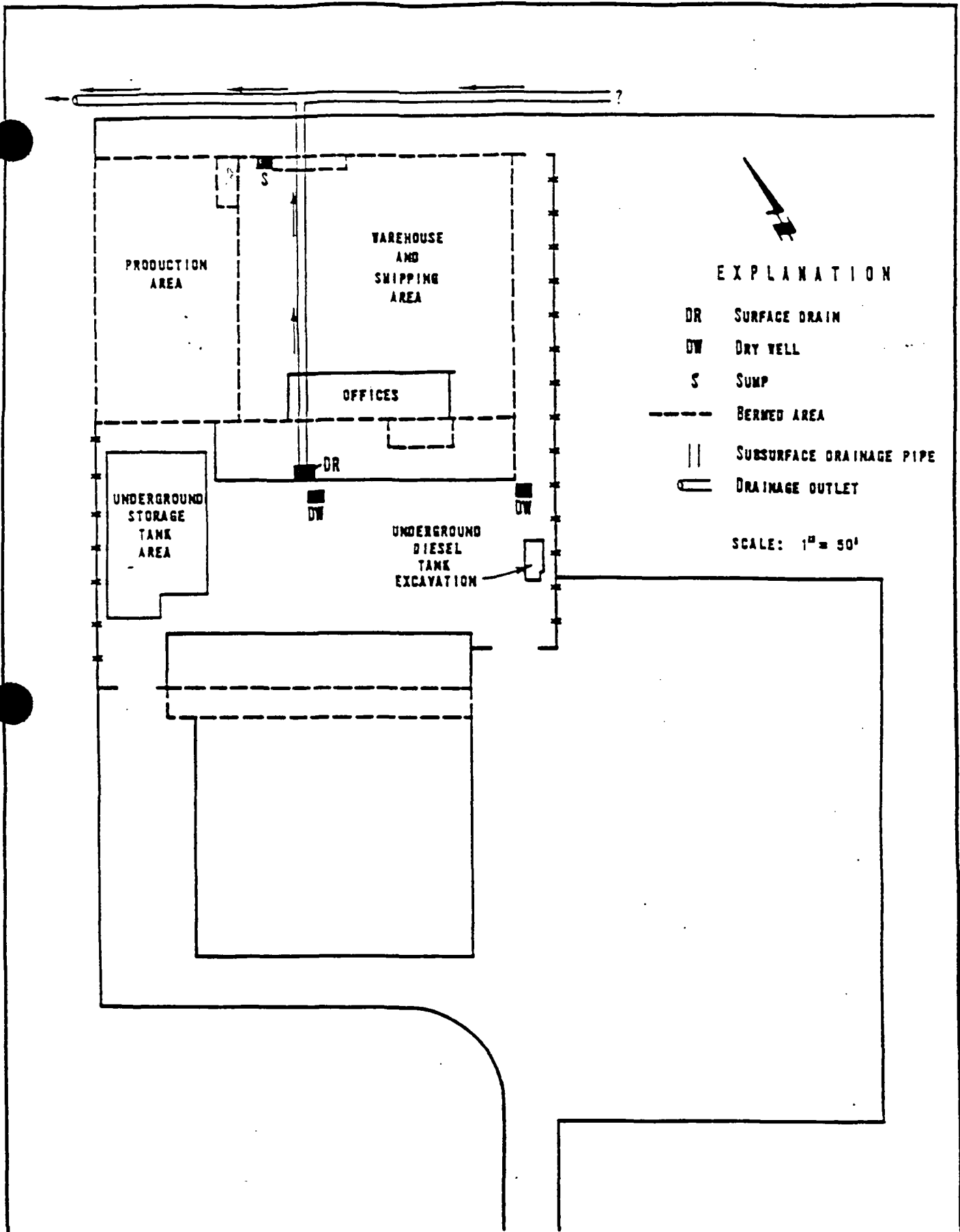
### 2.3.1 Hydrology

The Jasco site is at an approximate elevation of 60 feet above mean sea level. The surrounding topography slopes gently toward the north-northeast at approximately 100:1 (horizontal to vertical). Surface water on the developed portion of the site drains generally toward the north-northeast, toward the main building. Presently, a portion of the surface runoff flows into a drain which outlets off the northwest corner of the site, adjacent to the Southern Pacific Railroad Line. There, the discharged water ponds and evaporates and/or percolates into the soil. Surface runoff from the non-paved portions of the site is limited, as the site is virtually flat, non-landscaped, and has not developed a significant drainage network.

Permanente Creek, located approximately 600 feet northwest of the site, flows north-northeast toward San Francisco Bay (located 4.5 miles to the north). The creek is concrete-lined, channelized, and is used primarily for drainage and flood control.

### 2.3.2 Local Geology

The Jasco site is underlain by a thick sequence of unconsolidated sediments of Upper Plio-Pleistocene and Holocene ages. These sediments are considered to extend to a depth of 1,500 feet within the Santa Clara Valley basin, thinning southward to the base of the Santa Cruz Mountains. Benthic bay muds are not considered to form significant deposits in the ancestral Santa Clara Valley, due to the fact that the San Francisco Bay is considered by Helley (1979) not to have extended beyond its current shoreline. However, as sea level rose (transgression) into south San Francisco Bay, estuarine marshlands developed southward into the ancestral Santa Clara Valley. With the transgression of the marshes



JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA



JACOBS ENGINEERING GROUP INC.

SURFACE DRAINAGE CONTROL SYSTEM  
AND EXTENT OF BERMED AREAS

FIGURE

2-3

landward, much of the (earlier) coarse-grained alluvial and fluvial deposits were buried by finer grained material. The estuarine deposits became laterally quite extensive during both transgressive and regressive events. Subsequently, in response to increased continental glaciation, the sea level of the ancestral San Francisco Bay dropped, and the previously deposited marsh deposits were regionally eroded, reworked, or buried by renewed alluvial and fluvial processes. Stratigraphically, this produced the general sequence of alternating fine and coarse grained materials.

Descriptions of regional geology can be found in the Endangerment Assessment for the Middlefield-Ellis-Whisman Site in Mountain View, California, prepared by Camp Dresser & McKee, Inc. by ICF-Clement, July 1, 1988. Modified excerpts from this document regarding the regional geology are located in Appendix A as Attachment 1.

### 2.3.3 Local Hydrogeology

The following information on the Jasco site hydrogeology is taken from a report prepared for Jasco by Wahler Associates, "Evaluation of Interim Remedial Alternatives," June 1988.

Three higher permeability aquifer units have been identified within the upper 70 feet section at and adjacent to the Jasco facility. The three higher permeability units have been designated the A-, B<sub>1</sub>-, and B<sub>2</sub>-aquifers. Figures A-1 and A-2 present geologic cross-sections prepared from borehole stratigraphic data. Cross-section locations are presented in Figure A-3.

The A-aquifer within the study area is encountered at depths ranging from 22.0 to 35.5 feet below ground surface. The thickness of the A-aquifer ranges from 3.0 to 13.5 feet. The bottom of the A-aquifer extends to depths of 28.0 to 42.7 feet below ground surface.

The B<sub>1</sub>-aquifer is encountered at depths ranging from 42.0 to 47.5 feet below ground surface with the bottom of the aquifer at depths ranging from 54.5 to 57.5 feet. The thickness of the B<sub>1</sub>-aquifer ranges from 7.5 to 11.2 feet. Analysis of pumping test data indicates that the A- and B<sub>1</sub>-aquifers may be hydraulically connected within the study area. The B<sub>1</sub>-aquifer is separated from the underlying B<sub>2</sub>-aquifer by a low permeability unit designated as the B<sub>1</sub>-B<sub>2</sub> aquitard.

Drilling logs indicate that the C-aquifer is approximately 150 feet below ground surface and is separated from the B-aquifer by the B-C aquitard. The B-C aquitard consists of two clay layers, 7.9 and 12.1 feet in thickness. The confining layers are separated by a 20-foot thick cemented gravel layer (refer to drillers logs, Appendix A) (Wahler Associates, Site Inspection Report, June 1987).

Based on the existing site data, a summary of the aquifer systems beneath the Jasco site is as follows:

Approximate Depths Below	
Zone	Ground Surface
A	22.0 - 35.5 feet
B <sub>1</sub>	44.5 - 56.0 feet
B <sub>2</sub>	*57.5 feet
C	150 feet

\*Encountered in only one boring

Under non-pumping conditions, the movement of ground water within the A-aquifer is towards the northeast (N30°E) with an average gradient of 0.004 ft/ft. The direction of ground water flow within the B<sub>1</sub>-aquifer is N15°E, with an average gradient of 0.003. Potentiometric surface maps of the A- and B<sub>1</sub>-aquifers were prepared from data collected on October 7, 1987, during non-pumping conditions and are presented as Figure A-4 and A-5, respectively.

Currently, neither the A- nor B<sub>1</sub>-aquifers are used for drinking water purposes in the vicinity of the Jasco site. The City of Mountain View operates several municipal wells in the general area which draw water from the C-aquifer.

A description of the regional hydrology is presented in Appendix A as Attachment 2.

#### 2.3.4 Climatology

The San Francisco Bay Area has a characteristic Mediterranean climate with mild wet winters and warm dry summers. The South Bay Area exhibits considerable climatic variability compared to San Francisco with respect to temperature, cloudiness, and sunshine. The Santa Clara Valley lies in the path of winter storms which sweep inland from the North Pacific. Freezing temperatures and snow are extremely rare. Rainfall from the winter storms ranges from moderate to heavy. Climatic data from

the Mountain View Corporation Yard (period of record 1975 to present) and the Los Altos Fire Department weather station (period of record 1965 to present) are the most representative for the study area. According to these records, the average annual rainfall is about 14 inches. Over 75% of the total annual rainfall for this area occurs during the winter months of November through March. The average annual wind speed is approximately 6 to 7 mph, with slightly stronger winds occurring during the summer (ICF-Clement, July 1988).

The nearest pan evaporation station is the Alamos station in southern San Jose. Based on data from this station, and allowing for seasonal variations in both precipitation and evaporation rates, Harding Lawson Associates (1987) has estimated that approximately eight inches of precipitation per year is potentially available for recharge to the local aquifers. However, recharge to the ground water is probably low due to the high degree of urbanization (ICF-Clement, July 1988).

## 2.4 Remedial Activities

On August 3, 1987, the California Regional Water Quality Control Board (CRWQCB) issued Jasco Clean-up and Abatement Order (CAO) Number 87-094. The CAO contained certain provisions for bringing the facility into compliance and a schedule for completion. The Jasco site has been proposed for inclusion on the Superfund National Priorities List (NPL) by the United States Environmental Protection Agency (EPA).

Preliminary ground water and soils investigations were performed at the Jasco site to determine the nature and extent of potential contamination. The results of the investigations revealed contamination of ground water and soils with chemicals of the same type used and/or stored at the Jasco facility. Subsequent investigations were performed to determine the source and spatial distribution of the contamination problem. Tables A-1 through A-4 in Appendix A presents summaries of the analytical results for ground water, surface water and soils. Reported low and high concentrations of contaminants are presented in Tables 2-1 through Table 2-3.

Jasco and their consultants have been performing ground water remediation activities since February 20, 1987. The concentration of chemicals detected within the vadose zone are confined to a limited area near the northwestern corner of the Jasco facility. The contamination is located in a drainage swale which receives storm water runoff via a subsurface drain pipe. The contamination extends from near-surface to a depth of 21.5 feet. The chemical contamination at this area consists mainly of volatile organic compounds (VOCs) such as paint thinner, methylene chloride, and 1,1,1-TCA. Remedial

TABLE 2-1  
SUMMARY OF CONTAMINANTS DETECTED  
IN GROUND WATER (A-AQUIFER)

Contaminant	<u>Highest Reported Value</u>		<u>Lowest Reported Value</u>	
	Concentration	Location	Concentration	Location
	mg/l		mg/l	
Acetone	1.80	V-2	0.003	V-8
Benzene	0.02	V-2	0.0019	V-6
Chloroethane	0.180	V-2	0.0031	V-1
1,1,-Dichloroethane	2.2	V-4	0.00069	V-8
1,1,-Dichloroethene	0.17	V-4	0.00065	V-8
1,2,-Dichloroethane	2.58	V-2	0.0010	V-3
Trans 1,2-Dichloroethene	0.013	V-2	0.0014	V-1
Ethylbenzene	0.057	V-2	0.0076	V-2
Methylene Chloride	142.0	V-2	0.0014	V-1
Methyl Ethyl Ketone	0.15	V-2	0.004	V-1
Pentachlorophenol	0.05	V-3	0.0002	V-1
Trichloroethylene	0.008	V-2	0.006	V-2
Toluene	0.360	V-2	0.0038	V-4
1,1,1-Trichloroethane	2.04	V-2	0.0018	V-3
Trichloroethene	0.019	V-2	0.0022	V-2
Vinyl Chloride	0.016	V-4	0.00068	V-3
Xylene	0.062	V-2	0.008	V-3

TABLE 2-2  
SUMMARY OF CONTAMINANTS DETECTED  
IN SURFACE WATER

Contaminant	<u>Highest Reported Value</u>		<u>Lowest Reported Value</u>	
	Concentration mg/l	Location	Concentration mg/l	Location
Acetone	0.290	Ponded Water/ Drainage Swale	ND <sup>(1)</sup>	
Benzene	ND		ND	
Chloroethane	ND		ND	
1,1,-Dichloroethane	.056	Ponded Water/ Drainage Swale	0.0039	Discharge Pipe
1,1,-Dichloroethene	ND		ND	
1,2,-Dichloroethane	ND		ND	
Trans 1,2-Dichloroethene	ND		ND	
Ethylbenzene	ND		ND	
Methylene Chloride	1.30	Ponded Water/ Drainage Swale	0.014	Roof Downspout
Methyl Ethyl Ketone	ND		ND	
Pentachlorophenol	0.200	Ponded Water/ Drainage Swale	ND <sup>(2)</sup>	
Tetrachloroethylene	ND		ND	
Toluene	ND		ND	
1,1,1-Trichloroethane	0.700	Ponded Water/ Drainage Swale	0.0130	Ponded Water/ Drainage Swale
Trichloroethene	ND		ND	
Vinyl Chloride	ND		ND	
Xylene	0.0098	Ponded Water/ Drainage Swale	ND	

(1) Not detected.

(2) Only one value reported.



TABLE 2-3  
SUMMARY OF CONTAMINANTS DETECTED  
IN SOILS

Contaminant	<u>Highest Reported Value</u>		<u>Lowest Reported Value</u>	
	Concentration mg/l	Location	Concentration mg/l	Location
Acetone	278.0	Drainage Swale	1.1	Drainage Swale
Benzene	3.0	Drainage Swale	ND(1)	Drainage Swale
Chloroethane	---(2)	---	---	---
1,1,-Dichloroethane	27.0	Drainage Swale	0.34	Drainage Swale
1,1,-Dichloroethene	13.0	Drainage Swale	ND	Drainage Swale
1,2,-Dichloroethane	3.98	Drainage Swale	ND	Drainage Swale
Trans 1,2-Dichloroethene	4.80	Drainage Swale	ND	Drainage Swale
Ethylbenzene	170.0	Drainage Swale	---	---
Methylene Chloride	3400	Drainage Swale	0.99	Drainage Swale
Methyl Ethyl Ketone	ND	Drainage Swale	ND	Drainage Swale
Pentachlorophenol	0.20	0.15ft Well V-2	0.009	20-35ft Well V-2
Tetrachloroethylene	16.0	Drainage Swale	.0067	Drainage Swale
Toluene	1700.0	Drainage Swale	61.0	Drainage Swale
1,1,1-Trichloroethane	22.0	Drainage Swale	0.11	Drainage Swale
Trichloroethene	490.0	Drainage Swale	0.088	Drainage Swale
Vinyl Chloride	ND	Drainage Swale	ND	Drainage Swale
Xylene	91.0	Drainage Swale	1.70	Drainage Swale

(1) Not Detected: Applies to contaminants where only one value was reported.

(2) Not Analyzed.

activities have included excavation of soils from the contaminated area. Figure A-6 in Appendix A presents a summary of chemical analysis results in soils at the drainage swale.

The highest chemical concentration in the A-aquifer has been detected at the northwest corner of the Jasco site, adjacent to the drainage swale where concentrations of chemicals have been detected within the vadose zone soils. Chemicals in the A-aquifer have migrated down-gradient as far as the northern shoulder of the Central Expressway. Isoconcentration maps showing the distribution of chemical concentrations within the A-aquifer are presented as Figures A-7 through A-10. The concentration of chemicals detected within the B<sub>1</sub>-aquifer (see Figure A-11) are below DOHS recommended action levels.

Contamination of the A and B<sub>1</sub>-aquifers from other sources in the area have been documented. The contaminated sites located down-gradient or cross-gradient from the Jasco site include: the Teledyne and Spectra Physics sites located 0.88 miles north of the site; the CTS Printex site, located 1.36 miles north of Jasco; the "Mountain View 5" sites located 1.50 miles east of Jasco; Hewlett Packard, Logue Avenue site located, 2.20 miles east of the Jasco site, and Moffett Field Naval Air Station, located 2.27 miles northeast of Jasco. The Hillview-Elanor plume is located up-gradient and approximately 1.72 miles southwest of Jasco (Wahler Associates, Site Inspection Report, June 1987).

Although this Endangerment Assessment assumes a no remediation scenario, the remediation processes that have been previously described cannot be ignored. These processes have significantly altered the collected and evaluated data, and therefore a "true" no remediation condition does not exist.

## SECTION 3.0

### INDICATOR CONTAMINANT SELECTION

#### 3.1 Introduction

To evaluate the potential impacts that the Jasco site may have on human health, indicator contaminants were selected from chemical compounds identified in ground water, surface water, and soil samples obtained during the remedial investigation. In order to focus the assessment on those contaminants which potentially pose the highest risk, the contaminants were evaluated with respect to their relative toxicity, mobility, prevalence on-site and persistence. From this data, a subset of indicator chemicals was developed. This section explains the approach used to identify the contaminants on-site and the methodology used to adjust and finalize the indicator chemical list. Tables and work sheets showing the indicator containment selection process are presented in Appendix B.

#### 3.2 Indicator Contaminant Selection Methodology

The indicator contaminant selection process involved a review of site characterization data. These include the Preliminary Ground Water Investigation Report (Questa Engineering Corp., 1984), Phase I Hydrogeological Investigation Report (Wahler Associates, 1987) and Surface Water and Soil Sampling Investigation Report (Wahler Associates 1988) as well as chemical-specific physical and toxicological data. The toxicity and physical property data were obtained from the Superfund Public Health Evaluated Manual (SPHEM) along with the appropriate methodology for indicator contaminant selection (USEPA 1986).

The selection of the indicator contaminants focuses on the toxicological properties of the contaminants detected in ground water, surface water and soil. The final list of the indicator contaminants provides a cross section of carcinogenic and non-carcinogenic contaminants that are representative of the most toxic, persistent and mobile contaminants identified through monitoring.

The indicator contaminants were selected from a list of contaminants known to be present at the Jasco site. This list is presented in Table B-1 and was developed from a review of historical documents and available site characterization data. From this list the initial indicator contaminants were selected. Aliphatic hydrocarbon mixtures such as paint thinner and lacquer thinner were not evaluated in the indicator scoring process except when the components of these compounds were analyzed for separately. Gasoline was not represented in the indicator scoring process as it contains aromatic hydrocarbons such as, ethylbenzene and xylene. Individual components were sometimes analyzed for

and when available, the data were considered in the scoring process. Contaminants that were infrequently detected during a series of testing programs and/or at low concentrations were not considered representative of site conditions, therefore they were not included on the initial indicator contaminant list.

Concentrations of the contaminants were identified as maximum and representative (mean) concentrations observed during remedial investigation activities. Toxicity data for each contaminant were compiled and reviewed.

Indicator scores for each contaminant were calculated by multiplying the maximum and representative concentrations by the toxicity constant for the specific environmental media. Indicator scores and factors related to environmental mobility and persistence and other chemical and physical characteristics were compiled for each contaminant. The final selection of indicator contaminants was made on the basis of the indicator scores and environmental mobility and persistence.

The specific selection process for indicator chemicals is described in SPHEM (USEPA 1988). Each step in the process is documented in Tables B-1 through B-7. The final indicator contaminants selected include potential carcinogens and non-carcinogens and contaminants exhibiting both qualities. Table 3-1 presents a list of the final indicator contaminants selected.

### **3.3 Health Effects of Indicator Contaminants**

The following presents a summary of the adverse health effects associated with exposure to the individual indicator contaminants. Extensive discussions of the toxicological properties and regulator criteria are presented in Appendix B as Attachment 1.

#### **1,2-Dichloroethane**

Human data on subchronic oral toxicity of 1,2-Dichloroethane (1,2-DCA) are not available, and the only available animal data provide inconclusive evidence that effects on the immunological systems of rats and mice are due entirely to 1,2-DCA. However, subchronic inhalation studies in animals have identified rabbits as the most resistant and guinea pigs as the most sensitive to the adverse effects of 1,2-DCA (Spencer et al. 1951). Large doses of 1,2-DCA given to rats have led to high mortality rate in males and females due to toxic, not carcinogenic, effects (USEPA 1984). Chronic occupational exposures to 1,2 DCA have been documented. In most cases inhalation of 1,2-DCA has produced

TABLE 3-1  
FINAL INDICATOR CONTAMINANT LIST

Indicator Contaminant	Carcinogen	Non-Carcinogen	Ranking(1)	
			Potential Carcinogens	Non- Carcinogens
1,2-Dichloroethane	X		1	5
1,1-Dichloroethene	X	X	3	2
Trichloroethene	X		4	2
Vinyl Chloride	X		5	6
Benzene	X		6	10
Tetrachloroethylene	X	X	7	16
Methylene chloride	X	X	2	3
1,1-Dichloroethane		X	---	4
Pentachlorophenol		X	---	8

1) Ranked by maximum indicator score values.

symptoms such as nausea, vomiting, anorexia, irritation of the eyes and respiratory tract (USEPA 1984c).

Animal bioassays provide significant data on the carcinogenic potential of 1,2-DCA. In a 1978 NCI Study it was found that oral doses of 1,2-DCA given to rats produce various tumors in male and female rats (USEPA 1984c). No data are available on the teratogenic effects of oral or inhaled 1,2-DCA in humans or of oral 1,2-DCA in animals. Animal data on inhaled 1,2-DCA have been inconclusive (USEPA 1984c).

#### 1,1-Dichloroethylene

1,1-Dichloroethylene (1,1-DCE) is commonly known as vinylidene chloride. Animal studies, conducted since the early 1960s, have provided almost all of the information from which human effects can be assessed. Subchronic inhalation data have revealed that continuous exposure to concentrations up to 395 mg/m<sup>3</sup> result primarily in liver and kidney damage in rats, guinea pigs and monkeys. High exposure to 1,1-DCE in drinking water appears to produce adverse liver changes in male and female rats (USEPA 1984d).

Animal bioassays with respect to oral treatment of rats and mice with 1,1-DCE have not found evidence of carcinogenicity. However, inhalation studies on rats and mice have demonstrated a possible relationship between mammary tumors in both species and kidney tumors in male mice (Maltoni et al. 1980). Oral studies on the teratogenicity and reproductive effects have been inconclusive, whilst inhalation studies on rats have found fetotoxic effects (Murray et al. 1979).

#### Trichloroethylene

Inhalation exposure to trichloroethylene (TCE) 2900 ppm has produced lethality in humans and a single oral dose of 7000 mg/kg has also been reported to be lethal to humans (ATSDR 1988b). The primary target organ effected by inhalation exposure is the central nervous system (ATSDR 1988b). Inhalation studies in rats and mice found acute and intermediate duration exposure have produced liver enlargement, increased kidney weight and some liver cell alterations (Kjellstrand et al. 1983). Animal oral studies have suggested adverse effects to the immune system (Tacker et al 1982).

Human studies on the carcinogenicity of TCE are reported in the literature for inhalation exposure, but not oral exposure. In particular, several epidemiological studies completed between 1978 and 1985 found significant excesses of cancer above background with the exception of bladder cancer and

lymphoma in one study (ATSDR 1988b), there is inconclusive data available on the developmental toxicity of oral or inhaled TCE to humans. Inhalation studies in rats have found that TCE is fetotoxic, decreases fetal weight and increases litter resorption. Oral exposures to TCE have shown alteration in male rat mating behavior and reduced prenatal survival rate in mice (ATSDR 1988b).

#### Vinyl Chloride

Inhalation exposure to vinyl chloride has been reported as lethal in high (unquantified) concentrations. Animal studies on rats and mice have indicated that both inhalation and oral exposure to vinyl chloride decreases longevity (ATSDR 1988).

Occupational epidemiology has led to the association of vinyl chloride exposure via inhalation, with various tumors including liver, brain and lung (ATSDR 1988b). Studies in rats and mice indicate that the carcinogenicity of vinyl chloride is manifested as an increased incidence in liver angiosarcomas in rats and lung cancer in mice even at low level inhalation exposures such as 50 ppb (ATSDR 1988c). Human data on inhalation exposures show that there may be an increased likelihood of fetal loss, and alterations in sexual function in both sexes (ATSDR 1988c).

#### Benzene

Accidental inhalation of benzene by humans has led to limited information on its lethality. It has been suggested that a level of 20,000 ppm for 5-10 minutes (continuous exposure) is an acutely lethal dose (Sandmyer 1981). Studies on rats suggest benzene inhalation has a low acute toxicity. There is a wide range of oral lethal doses reported for humans, the highest being 428 mg/kg (ATSDR 1987). Oral and inhalation studies on rats and mice have led to the conclusion that the systems most affected by benzene are primarily the hematopoietic and immune systems, and in some instances, the nervous system (ATSDR 1987).

Several epidemiological studies have been conducted since 1978 and these have been the basis for the assessment of the risk of leukemia from benzene exposure (ATSDR 1987). Inhalation exposure data revealed a unit risk of  $2.6 \times 10^{-2}$  for leukemia. Benzene has been found to be potentially fetotoxic to mice and rabbits, with effects such as decreased fetal weight evident when exposed to approximately 155 ppm via inhalation (ATSDR 1987). No data are available on oral or dermal exposure routes and no human data are available.

### Tetrachloroethylene

Inhalation studies on the lethality of tetrachloroethylene (PCE) in rats and mice have indicated decreased longevity in both species, at high concentrations (1600-1750 ppm) over extended periods of exposure (14 days-13weeks) (ATSDR 1988c). The primary target organs effected by PCE exposure are the central nervous system, liver and kidney.

Inhalation exposure to PCE has been found to result in an elevated mononuclear cell leukemia rate in rats of both sexes and an elevated hepatocellular carcinoma incidence in mice of both sexes (NTP 1986). Animal data on the results of inhalation exposure to PCE showed mice to have an increased number of embryotoxic effects such as split sternabrae and an increased percentage of fetal resorption (ATSDR 1988a).

### Methylene Chloride

The only animal study on oral subchronic exposure to animals defined a no-observed-effect-level of 12.5 mg/kg/day in rats (USEPA 1983). Subchronic inhalation exposure to methylene chloride in rats, mice and monkeys appears to be associated with liver and kidney lesions (USEPA 1983). Reported occupational exposure to methyl chloride involved symptoms ranging from mild light headedness to toxic incephalosia following five years of direct contact with the compound daily. A 1983 study (Ott et al.) found no increase in mortality, in men and women, due to cardiopulmonary disease or malignant neoplasm associated with methyl chloride exposure.

Oral exposure bioassays on both rats and mice have found methyl chloride to produce a small but significant increase in the incidence of hepatocellular tumors leading to EPA to conclude the compound has "borderline carcinogenicity" (USEPA 1984f). Animal studies on rats and mice have found significant reductions in fetal body weight and some accelerated bone development in the respective species (USEPA 1984f).

### 1,1-Dichloroethane

Very few studies on animals have been completed, but inhalation exposures of 1000 ppm to cats revealed renal alterations when exposure continued for five days per week for thirteen weeks. Oral exposure studies in rats have found that sustained high levels of exposure to 1,1-Dichloroethane



(1,1-DCA) produces significant increase in mortality rate and associated renal damage (USEPA 1984b).

Bioassays conducted on rats have found significant increases in mammary adenocarcinoma incidence following chronic oral exposure to 1,1-DCA (USEPA 1984b). However other carcinogenicity tests have failed to find a relationship between 1,1-DCA and tumor incidence (USEPA 1984b). Studies on rats exposed to 1,1-DCA during gestation, via inhalation, show significant alteration in bone ossification of the offspring (Schwetzter et al. 1974).

#### Pentachlorophenol

Reports describing PCP poisoning in workers or from improper use of PCP-containing products in the home by individuals indicates that brief exposure to high levels of PCP can cause adverse health effects on the liver, kidney, skin, blood, lungs, nervous system, gastrointestinal tract, and death. Long-term exposure to lower levels of PCP can result in damage to liver, blood and nervous system, but the routes of exposure (dermal, oral, inhalation) have not been separated.

There is no convincing evidence from epidemiological studies that indicate that PCP produces cancer in humans. Case reports suggest a possible association between cancer (Hodgkin's disease, soft-tissue sarcoma and acute leukemia) and occupational exposure to technical PCP. (Fingerhut et al., 1984; Greene et al., 1978; Roberts, 1983). However in all these cases the possibility of concurrent exposure to other toxic substances cannot be excluded.

Evidence does exist from animal studies to consider PCP a probable human carcinogen. The best evidence comes from a recent study conducted by the National Toxicology Program (NTP, 1988). The study compared the carcinogenic effects of two PCP preparations, TG-penta and Dowicide EC-7, by oral exposure to mice for two years. EC-7 contained lower levels of the toxic impurities debenzo-p-dioxins and debenzofurans. The incidence of hepatocellular adenomas/carcinomas, adrenal medullary pheochromocytomas (benign and malignant) and hemangiomas/hemangiosarcomas (predominantly in the spleen and liver) was significantly increased in both studies in one or both sexes. In other carcinogenicity studies of various polychlorinated debenzo-p-dioxins only hepatocellular tumors were seen, therefore it can be concluded the PCP itself possesses oncogenic activity.

## SECTION 4.0

### EXPOSURE ASSESSMENT

#### 4.1 Introduction

The purpose of the Exposure Assessment section of the Jasco Endangerment Assessment is to determine the extent to which the populations surrounding the Jasco site may be exposed to the contaminants released into the environment as a result of past and current Jasco depositions. To accomplish this objective, the following items were evaluated.

- o Study area characterization
- o Potential exposure medias
- o Potential exposure pathways

Once complete pathways were determined, exposure point concentrations of indicator contaminants were determined.

#### 4.2 Study Area Characterization

The study area for this Endangerment Assessment encompasses approximately 138 acres, bounded by Mariposa Avenue on the east, Euscala Avenue on the west, Highway 101 on the north and California Street on the south (see Figure 4-1). The study area is not related to the extent of the Jasco site impact and actually encompasses an area larger than the impacts identified in the remedial investigation. Existing land-uses for the Jasco study area were identified by a field survey. Although the study area primarily supports residential areas, an industrial area and commercial area does exist. Residential areas comprise approximately 90% of the study area. Current City of Mountain View ordinance designate the entire study area as residential zoning.

The Jasco site is the only remaining industrial complex in the study area. Jasco's conditional use permit from the rezoning requires that the company evacuate its present location by 1992. The Jasco site comprises approximately 1.5% of the total study area. One business office complex is located within the study area. The complex is located southeast of Jasco and occupies approximately 8% of the total study area.

The following population data was obtained from information obtained in an Endangerment Assessment report for the Middle-Ellis-Whisman (MEW) site, located approximately 1.5 miles east of the Jasco study area. The report included population data within a three mile radius of the MEW site which includes the Jasco study area. While data from the Endangerment Assessment report

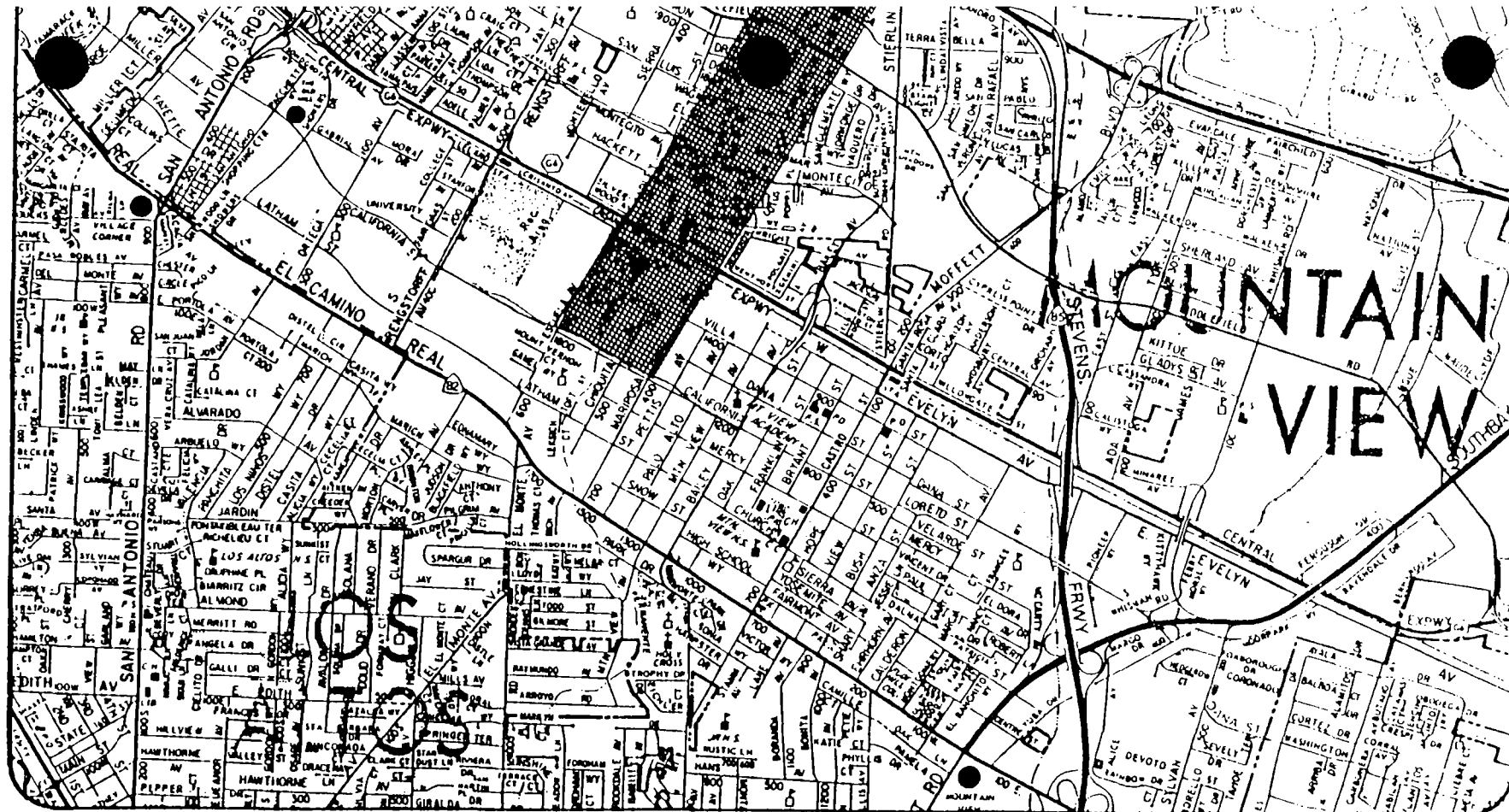


Figure 4-1  
Jasco Endangerment Assessment  
Study Area

encompasses an area larger than the Jasco study area, the data can be used to evaluate general population trends.

The current population within the Jasco study area is approximately 900, with an annual growth rate of 0.2%. The current average family size is three with no major changes forecast for 1992. The current median and average ages are 36.6 and 38.6, respectively. Adults over 44 years of age comprise 53.4% of the population, with adults in the 30-40 year range comprising 30% of the population. Most children are in the 5-11 year old range with 7% of the total population, followed by the 0-4 year old range with 5% of the total population, and the 12-16 year old range with 4.6% of the total population.

#### **4.3 Potential Exposure Media**

At the Jasco site, contaminants have been detected in surface waters, ground water, and soils. Since the indicator contaminants have been found in these media, they are suspected of contributing to the potential exposure of a receptor. The following sections provide insights and evaluation of the particular medias and qualitatively address the potential exposure routes.

Information to date indicates that the primary concern at the Jasco site is the potential for, or existence of, ground water contamination. Because of this, special emphasis is placed on describing and evaluating the ground water pathway.

##### **4.3.1 Ground Water Exposure Media**

Ground water is regulated by the Santa Clara Valley Water District (SCVWD) with a fee charged for ground water withdrawal. Neither the A or B<sub>1</sub>-aquifers are currently used for drinking water purposes in the vicinity of Jasco. SCVWD records indicate that there may be old agricultural wells in existence within one mile of the Jasco site. However, a large percentage of the agricultural and private wells in Mountain View have been abandoned under the supervision of the SCVWD. Currently agricultural uses of water are practically non-existent in Mountain View.

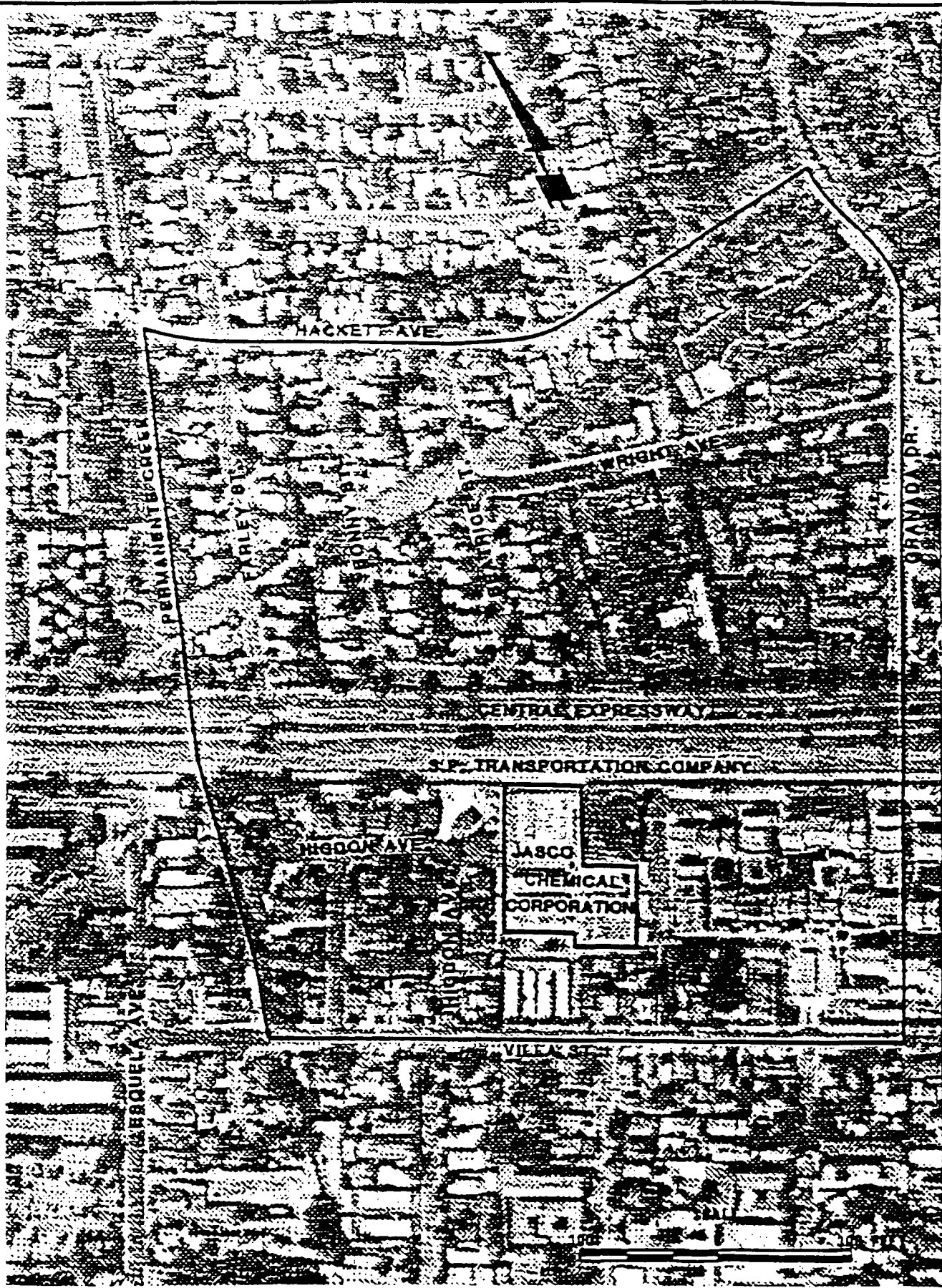
It does not appear that contaminants will migrate to any of the City of Mountain View's municipal water supply wells. This is based on the current locations of these wells with respect to the contaminant plume trend, regional hydraulic gradients, and hydrostratigraphic constraints. The municipal water supply wells are completed within the C-aquifer which occurs at a depth of approximately 150 feet below the surface and is separated from the A-aquifer by several aquitard units of which the most noteworthy is the B-C aquitard. The B-C aquitard has never been encountered at

the Jasco site due to the lack of any deep exploratory drilling. The B-C aquitard has been investigated thoroughly by Harding Lawson Associates for a study area located approximately two miles east of the Jasco site. Harding Lawson indicates the B-C aquitard to be generally 20-40 feet thick, consisting predominantly of stiff silty clay with occasional sand lenses. Therefore, the C-aquifer is effectively isolated from the overlying aquifers by the B-C aquitard with the exception of where local conduits may provide hydraulic interconnection. (Harding Lawson Associates, 1987).

A potential conduits investigation was performed by Wahler Associates for Jasco to satisfy the requirements of Cleanup and Abatement Order (CAO) No. 87-094. The objective of the investigation was to assess the potential for contaminants to migrate from shallow to deeper ground water resources via unsealed or improperly sealed wells with multiple perforations or annular gravel packs which may be in contact with contaminated ground water. The investigation also included an assessment of the potential for horizontal migration of contaminants via activities resulting from residential and industrial development such as utilities excavations, storm sewers, and the Hetch-Hetchy aqueduct. The conduit inventory region is bounded on the south by Villa Street; on the north by Hackett Avenue; on the west by Permanente Creek; and on the east by Granada Drive (see Figure 4-2). The investigation indicated a total of five active, inactive and decommissioned water producing wells within the inventory region (see Figure 4-3). One of the wells (F01), is the Jasco A-aquifer monitoring well V-4. The SCVWD indicated two other wells (G03 and G04) were decommissioned in 1966, with the method of decommissioning unknown. These wells are located on the eastern border of the inventory region and should not be affected by the Jasco plume. The two additional wells seen on Figure 4-3 (D#1 and C#2) were identified by aerial photo interpretation as part of the South Bay Multi-Site Cooperative Agreement Investigation. A field check by Wahler personnel failed to locate these wells. The investigators indicated that a tool shed near the location of well C#2 and a cement encased housing for intake/release valves associated with the Hetch-Hetchy aqueduct near the location of well D#1 may have been mistakenly identified as well pump houses. The investigators indicated there were no other water producing wells located within the inventory region. The only monitoring wells located in the inventory region are the Jasco site monitoring wells.

#### Contaminant Release and Transport Mechanisms in Ground Water

Ground water flow and contaminant transport follow complex patterns in alluvial/fluvial sediments such as those of the Santa Clara Valley. This is primarily due to the variations in the materials and physiochemical interactions between subsurface materials and the chemical solutes in ground water.



JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA

CONDUIT INVENTORY REGION

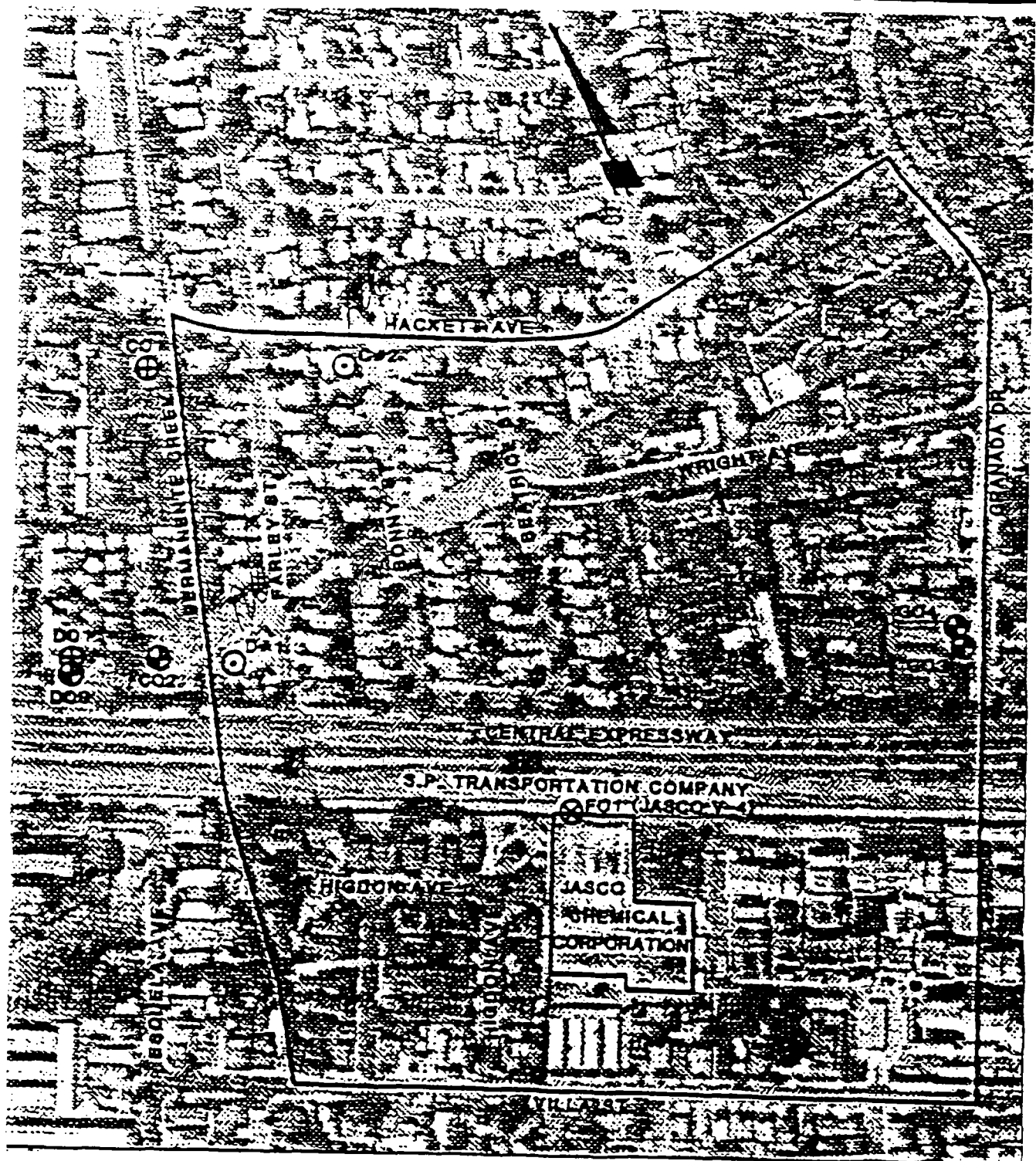
FIGURE

4-2



JACOBS ENGINEERING GROUP INC.

Source: Wahler Assoc.



JASCO CHEMICAL CORPORATION  
MOUNTAIN VIEW, CALIFORNIA



JACOBS ENGINEERING GROUP INC.

PRELIMINARY WELL IDENTIFICATION  
SUMMARY  
(NOT INCLUDING MONITORING WELLS)

FIGURE

4-3

Source: Wahler Assoc.

Hydraulic conductivity is a measure of the relative ability of an aquifer to transmit water (also commonly known as coefficient of permeability). The permeability of sand and gravel is typically several orders of magnitude higher than that of silt and clay. Therefore, lenses and layers of sand and gravel are a preferential pathway for ground water flow and contaminant transport, with silt and clay layers serving as barriers to this flow (confining layers). In most cases, the majority of ground water flow is horizontal, following the subhorizontal orientation of the high-permeability layers. Some vertical flow occurs through the confining layers separating permeable zones with different hydraulic heads.

Detailed studies of the hydraulic characteristics of alluvial sediments demonstrate that estimates of contaminant flow based on measured hydraulic conductivities of specific units are often unreliable. Contaminant migration in complex alluvial environments are best defined by sampling and analysis of monitoring wells.



### Contaminant Migration

The dominant contaminant transport mechanisms are advection, dispersion and diffusion. Sorptive phenomena results in the retardation of contaminants. Further reductions in contaminant concentrations result from volatilization and microbial degradation (Ali, no date).

Advection is the process of physical transport of contaminants by the bulk movement of ground water. Dispersion refers to the mechanical spreading and mixing that occurs as ground water follows tortuous paths in randomly distributed sand and clay layers. Diffusion results from the movement of areas of high contaminant concentration to areas of less concentration by molecular forces. Sorption phenomena encompasses both adsorption and absorption processes. Adsorption is the adhesion of chemical molecules to particulate surface, while absorption connotes incorporating chemical molecules within the molecular structure of the subsurface materials.

The migration of volatile contaminants is proportional to the ground water velocity, modified by dispersion, diffusion, sorption, and volatilization effects. Dispersion and diffusion phenomena cause contaminants to spread, so that the margins of contaminant plumes are gradational rather than abrupt.

Sorption generally results in the retardation of contaminants in alluvial sediments. This may be due to clayey soils having a significant sorptive capacity for synthetic volatile organic compounds (VOCs). Concurrently, diffusion and refraction at interfaces between layers of high and low permeability are the main mechanisms of contaminant dissemination in lower permeability layers (Gilham and Cherry, 1982; Hubbert, 1940).

At the interface between the high and low permeability layers, the processes of diffusion and refraction dominate contaminant migration. At macro- and micro-scales, the principal component of ground water and contaminant flow in sandy layers is largely horizontal. In clayey layers, contaminant migration is largely vertical, occurring mainly by diffusion and enhanced where refraction occurs.

In coarse-grained materials, contaminant dispersion by molecular diffusion is considerably less than dispersion by advection. In the lower-permeability materials, dispersion of contaminants within a complex flow system occurs primarily through molecular diffusion. The driving mechanism for molecular diffusion is the continually changing contaminant concentration contrasts between relatively rapid moving water in the sandy layers, and the lower velocity water in the clayey layers (Gilham and Cherry, 1982).

The extent to which a contaminant advances within the lower-permeability layers depends largely on the thickness of those layers, their permeability, contaminant concentration contrast and time. This implies that higher concentrations of contaminants should be found at the boundaries of the low-permeability layers and concentrations should decrease inward until the layer reaches equilibrium (Gilham and Cherry, 1982).

Refraction of ground water flowlines occurs at the interface of two formations of differing hydraulic conductivity. The angle of refraction is proportional to the contrast in hydraulic conductivity, i.e., the greater the contrast in hydraulic conductivity, the larger the angle of refraction (Freeze and Cherry, 1979).

In summary, flowlines prefer to use high-permeability formations as conduits, and try to traverse low-permeability formations by the shortest route. In aquifer-aquitard systems with permeability contrasts of two orders of magnitude or more, flowlines tend to become almost horizontal in aquifers and almost vertical in aquitards (Freeze and Cherry, 1979). This implies that most contamination would be introduced from the more permeable sediments above, and then flow almost directly downward in the lower-conductivity sediments.

The quantity and direction of refracted flow is directly proportional to the pressure head difference between the two media of contrasting hydraulic conductivity.

#### 4.3.2 Surface Water Exposure Media

On-site surface water is limited to the runoff from the roof of the production/warehouse building and paved areas. The runoff is discharged to a drainage swale, located at the northeast corner of the site. Here the discharge water ponds and either evaporates or infiltrates into the soil. Surface water runoff is limited as the site is virtually flat non-landscaped and does not possess a coherent drainage pattern.

The nearest surface water body to the site is the Permanente Creek. Permanente Creek is approximately 600 feet to the northwest of the Jasco site and flows north-northwest towards the San Francisco Bay. It is concrete-lined and channelized for drainage control purposes. The sole use of Permanente Creek is for drainage and flood control. Surface water at the Jasco site does not drain into it.

#### 4.3.3 Air and Soils Exposure Media

Contaminated soils are confined to the Jasco site and are not easily accessible to the public. The contaminated zone is not in the normal Jasco working area, therefore is undisturbed. Although there is an obvious lack of surficial soil sampling, analysis of soil samples taken indicate that the high concentrations of chemicals occur in the 3-10 feet depth interval. Soil survey data also indicate that contaminated soils are restricted to the Jasco site and that surface soils in the contaminated zone are somewhat cemented and are not readily available for aeolian transport.

#### 4.4 Potential Exposure Pathways

The Endangerment Assessment for the Jasco site has attempted to be as comprehensive as possible, resulting in the consideration of a variety of potential exposure pathways/scenarios. These scenarios are also descriptive of two distinct time frames: 1) the current site condition, and 2) potential future land-uses of the site property and surrounding areas. The following discussions describe these time frames and the exposure implications of these scenarios based on exposure media.

##### 4.4.1 Current Land-Use

Exposure to indicator contaminants are not expected to occur under the current land-use of the Jasco site. This assumption is based primarily on the fact that Jasco will not be operating at the current location past 1992 and the inaccessibility to the contaminated areas. Exposure pathways associated with current land-use of the Jasco site are discussed below. A summary of the potential exposure pathways based on the following discussions for current site conditions are presented in Table 4-1.

##### Soils

The potential for exposure to contaminated soils by way of dermal absorption and/or incidental ingestion is assumed to be very low to non-existent. Contaminated soils are limited to the Jasco site in a confined area which is not easily accessible to the public and is not located in a normal work area. The potential receptors for the exposure medium are limited to Jasco employees and trespassers. Dermal absorption is insignificant due to the high volatility of the chemicals of concern. Ingestion of contaminated soils is highly unlikely since on-site activities, such as gardening, are not occurring under the current land-use conditions.

TABLE 4-1

POTENTIAL PATHWAYS OF EXPOSURE TO CONTAMINANTS ORIGINATING AT THE JASCO SITE UNDER  
CURRENT LAND-USE CONDITIONS

Exposure Medium	Potential Routes of Exposure	Potential Receptors	Pathway Completely	Potential for Substance Exposure
Soil	Dermal absorption, incidental ingestion.	Workers, trespassers.	No Contaminants are contained within 3-10 feet depth interval.	None
Air	Inhalation of VOCs and/or fugitive dust.	Workers, trespassers. Local population downwind of site.	No Contaminants are contained within 3-10 feet depth interval.	Very Low
Ground Water	Ingestion, inhalation, dermal absorption.	Local population. of Mt. View	No, public water supplemented with water from wells outside area of influence. No private wells are in use.	None

## Air

Jasco employees and residents, located down wind and adjacent to the Jasco site may potentially be exposed to volatile organics and/or contaminated fugitive dusts. Inhalation exposure from the volatilization of organic chemicals in the soils and contaminated fugitive dust is assumed to be very low. As stated in the previous section, the high concentrations of chemicals occur in the 3-10 feet depth interval and are therefore not exposed to the surface. It is also noted that the surface soils in the contaminated zone are somewhat cemented and are not readily available for aeolian transport. Therefore if the soils are not disturbed the potential for volatilization and aeolian transport is very low. Since the contaminated soils are not located in a normal working area, it is assumed that the contaminated zone would remain undisturbed.

## Ground Water

Potential contaminated exposure through ingestion inhalation, and/or dermal absorption of contaminants present in the ground water is non-existent. The reasons for this being the regulation of ground water use by the SCVWD and the results of the potential conduit investigation as discussed in the previous sections. Based on the available information it is unlikely that a significant public health risk would occur under the current land-use conditions.

- o The A-B-aquifers are not used as a drinking water source.
- o There are no water producing wells down gradient of the Jasco site, within the boundary of the potential conduit investigation.
- o Regulation of the ground water use by the SCVWD.

### 4.4.2 Potential Future Land-Use

Potential future land-use of the Jasco site is dictated by the zoning change to residential, which went into effect in December 1983. Therefore the most likely exposure scenario involves future residential use for the Jasco site. A summary of potential exposure pathways is based on the following discussion for potential future land-use and are summarized in Table 4-2.

TABLE 4-2

POTENTIAL PATHWAYS OF EXPOSURE TO CONTAMINANTS ORIGINATING AT THE JASCO SITE UNDER  
POTENTIAL FUTURE LAND-USE CONDITIONS

Exposure Medium	Potential Routes of Exposure	Potential Receptors	Pathway Completely	Potential for Substance Exposure
Soil	Dermal absorption, incidental ingestion.	Construction workers and on-site residents.	Yes, if surface is disturbed	Moderate, periodic and short-term.
Air	Inhalation of VOCs.	Nearby residents Construction workers on-site residents.	Yes, if surface is disturbed.	Very low, high volatility and dispersion.
	Fugitive dust.	Construction workers on-site residents.	Yes If surface is disturbed.	Moderate, periodic and short-term
Ground Water	Ingestion, inhalation, dermal absorption.	Local population	Yes, if private well installed in area of plume.	High

### Soils

Potential exposure to contaminants in soils via dermal absorption and incidental ingestion may occur as a result of on-site construction activities during the redevelopment stage of the Jasco property. This may include excavation type activities such as foundation, sewer, or utility line installation. This type of exposure is expected to be short-term with a low potential for repeated exposure.

Adult residents and children may become exposed to contaminants in soils as a result of gardening activities and playing. This would include both dermal absorption and incidental ingestion of contaminated soils. The contribution by dermal absorption is expected to be low due to the high volatility of the organic chemicals involved.

### Air

Residents located downwind and adjacent to the Jasco site and construction workers may potentially be exposed to airborne volatile organic and/or contaminated fugitive dust. Potential exposure may occur as a result of on-site construction activities during the redevelopment of the property. On-site residents including children may become exposed to airborne volatile organic and contaminated fugitive dust as a result of gardening activities and playing. Exposure to airborne volatile organics is anticipated to be infrequent and of short duration with concentrations greatly reduced by ambient air during dispersion. Exposure resulting from contaminated fugitive dust generation is also considered to be periodic and of short duration. The potential for exposure is expected to be moderate.

### Ground Water

Future land-use of the Jasco site may include the development and use of private supply wells completed within the contaminated A-aquifer. If these wells are utilized by the residents for drinking and showering, exposure to contaminants by way of ingestion of contaminated ground water and inhalation of volatile organic and dermal absorption may be significant

#### **4.4.3 Conclusions**

The following is a summary of the contents of this section.

1. Land-use in this Endangerment Assessment Study Area is predominantly residential, occupying approximately 90% of the land in the study area.
2. The residential population of the area is large and the current trend indicates that population growth is on the incline.
3. A and B-aquifers, are not used for drinking water purposes in the vicinity of the Jasco site. The City of Mountain View operates several municipal wells in the general area of the site which draw water from the C-aquifer. Agricultural uses are practically non-existent in the City of Mountain View. Sampling data from off-site wells suggest that ground water transport of site contaminants to public wells has not occurred to date. If private supply wells are completed within the A-aquifer and utilized for drinking and showering, exposure may be high.
4. Surface water within the study area has no commercial or residential use and is not considered a potential migration pathway.
5. Contaminated soils are limited to the site. Under current site conditions volatilization of organic chemicals and aeolian transport of contaminated fugitive dust are highly unlikely due to the fact that contaminants are contained within the 3-10 feet depth interval and surface soils are somewhat cemented. If these soils are disturbed during future-use (development and gardening activities) significant exposure to airborne volatile organics is anticipated to be low due to concentrations being greatly reduced by ambient air during dispersion.

#### **4.5 Exposure Point Concentrations**

The degree, or magnitude, of exposure to a contaminant is primarily reliant upon the exposure point concentrations. It was determined through past monitoring data that the drainage swale is the on site area which is the most contaminated. For this reason, the drainage swale area was determined to be the primary exposure point from which exposure point concentrations have been determined.

The concentrations in this Endangerment Assessment were determined and expressed in terms of long-term exposure (average concentrations over time) and short-term exposure (high concentrations over



time). Short-term exposure levels are the concentrations to which population may be exposed for short periods of time, usually 10 to 90 days. Long-term exposures are defined as the concentrations to which populations may be exposed over a long period of time, usually 70 years. This range of values was chosen to best illustrate the levels of exposures which can occur. Computerized models were used to estimate ground water contaminant distribution over a 70 year period. There were major uncertainties associated with estimating potential contaminant migration, through computerized models, from the Jasco site. Little hydraulic data was available for areas beyond the site and contaminant degradation and transport processes were not defined in accordance to field conditions.

Additional information on modeling efforts can be found in Appendix C. Summaries of exposure point concentrations are presented in Table 4-3 through Table 4-5.

#### 4.5.1 Exposure Point Concentrations Determination Methodology

The following conventions were used to characterize the concentration levels of indicator contaminants at the exposure points. High values were reported in order to illustrate the range of data and to estimate the high exposure concentrations. In cases where the indicator contaminants were reported as not detected in the sampling reports or where concentrations were reported as less than the upper bound value, the exposure value was conservatively assumed to equal the upper bound value. When estimating values determined through numerical modeling, the data points with concentrations less than established water quality standards or criteria were not used in determining the average concentration. All average concentrations were derived by taking the arithmetic mean (average) of the projected data point concentrations (numerical modeling) or sampling data obtained from sampling reports.

##### Ground Water

Average values were obtained by taking the average of all projected data point concentrations over a 70 year period determined by numerical modeling. High values were developed by selecting the data points which projected the highest concentration levels over time.

##### Soils

Average values were obtained by taking the average concentration of samples collected over space and time. High values were determined by adding the value of two standard deviations to the average

TABLE 4-3  
EXPOSURE POINT CONCENTRATIONS  
(GROUND WATER)

Indicator	Average	High
Contaminant	Concentration(1)	Concentration(2)
	(mg/l)	(mg/l)
1,2-DCA	$1.7 \times 10^{-1}$	$1.6 \times 10^1$
1,1-DCE	$5.5 \times 10^{-2}$	$3.3 \times 10^0$
TCE	$9.6 \times 10^{-1}$	$1.2 \times 10^2$
Vinyl Chloride	$3.1 \times 10^{-3}$	$9.8 \times 10^{-2}$
Benzene	$1.9 \times 10^{-2}$	$7.3 \times 10^{-1}$
Tetrachloroethylene	$5.8 \times 10^{-2}$	$4.3 \times 10^0$
Methylene Chloride	$6.8 \times 10^0$	$8.7 \times 10^2$
1,1-DCA	$2.0 \times 10^{-1}$	$1.3 \times 10^1$
PCP	$8.2 \times 10^{-3}$	$3.1 \times 10^{-1}$

- (1) Arithmetic mean of projected concentration levels over time determined through computerized modeling.
- (2) Arithmetic mean of projected highest concentration points over time determined through computerized modeling.

TABLE 4-4  
EXPOSURE POINT CONCENTRATIONS  
(SOILS)

Indicator	Average	High
Contaminant	Concentration(1)	Concentration(2)
	(mg/kg)	(mg/kg)
1,2-DCA	$1.0 \times 10^{-1}$	$9.9 \times 10^{-1}$
1,1-DCE	$2.2 \times 10^{-1}$	$3.6 \times 10^0$
TCE	$6.5 \times 10^0$	$1.2 \times 10^2$
Vinyl Chloride	$5.0 \times 10^{-2}$	$5.0 \times 10^{-2}$
Benzene	$9.8 \times 10^{-2}$	$8.0 \times 10^{-1}$
Tetrachloroethylene	$1.8 \times 10^0$	$1.6 \times 10^1$
Methylene Chloride	$4.8 \times 10^1$	$8.0 \times 10^1$
1,1-DCA	$1.2 \times 10^0$	$1.5 \times 10^0$
PCP	$1.0 \times 10^{-1}$	$3.0 \times 10^{-1}$

- (1) Average concentration equals the arithmetic mean of concentrations of samples collected over space and time.
- (2) High concentration equals adding the value of two standard deviations to the arithmetic mean value.

values. These values provide a rough estimate of the upper 95% confidence interval for the average concentration that an individual could be exposed to over a number of exposure events.

#### Air

Concentrations of contaminants in air, due to volatilization of contaminants detected in ground water, were assumed to be the same as those projected for ground water (Andelman 1985). This assumption is based on 100% volatilization of the contaminant. Therefore, average and high values are the same as those developed for ground water.

#### **4.6 COMPARISON TO OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)**

The section discusses "Applicable or Relevant and Appropriate Requirements" (ARARs) with respect to the Jasco site Endangerment Assessment. The purpose of this section is to compare actual and projected contaminant levels to ARARs. ARARs for indicator contaminants are used as a comparison to the exposure near and at the site. This comparison will indicate if there is an excessive exposure and potential risk to human health.

In the USEPA's July 1987 Interim Guidance on Compliance with ARARs, EPA defines applicable requirements as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitation promulgated under Federal and State law that specifically addresses a hazardous substance pollutant, contaminant, remedial action location or other circumstance at a CERCLA site (Inside Washington Publishers 1987). EPA also specifies relevant and appropriate requirements as "those cleanup standards, standards of control, or other substantial environmental protection requirements, criteria, or limitations promulgated under Federal and State law that while not 'applicable' to a hazardous substance pollutant, or contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and that their use is well suited to the particular site" (Inside Washington Publishers 1987). Potentially applicable requirements include Clean Air Acts National Ambient Air Quality Standards, and the Safe Water Acts Maximum Contaminant Level Goals (MCLGs).

At the Jasco site, exposure could occur through ground water, air and soil media. The following sections discuss ARARs and other criteria for each of these media and compare these standards or limitations against actual or projected contaminant levels for the indicator contaminant.

TABLE 4-5  
EXPOSURE POINT CONCENTRATIONS  
(AIR)(1)

Indicator Contaminant	Average Concentration(2) (mg/m <sup>3</sup> )	High Concentration(3) (mg/m <sup>3</sup> )
1,2-DCA	$1.7 \times 10^{-1}$	$1.6 \times 10^1$
1,1-DCE	$5.5 \times 10^{-2}$	$3.3 \times 10^0$
TCE	$9.6 \times 10^{-1}$	$1.2 \times 10^2$
Vinyl Chloride	$3.1 \times 10^{-3}$	$9.8 \times 10^{-2}$
Benzene	$1.9 \times 10^{-2}$	$7.3 \times 10^{-1}$
Tetrachloroethylene	$5.8 \times 10^{-2}$	$4.3 \times 10^0$
Methylene Chloride	$6.8 \times 10^0$	$8.7 \times 10^2$
1,1-DCA	$2.0 \times 10^{-1}$	$1.3 \times 10^1$
PCP	$8.2 \times 10^{-3}$	$3.1 \times 10^{-1}$

- (1) Vaporization of ground water, assumes 100% vaporization.  
 (2) The average concentration equals arithmetic mean of projected concentration levels in ground water over time determined through computerized modeling.  
 (3) High concentrations equals arithmetic mean of projected highest concentration points in ground water over time determined through computerized modeling.

#### 4.6.1 ARARs for Ground Water

The ARARs for current use of ground water in the vicinity of the Jasco site are standards and criteria established for drinking. Although there is currently no use of A-aquifer ground water for drinking in the vicinity of the Jasco site, the potential risk that would result if the ground water from this aquifer were ingested was evaluated using the MCLGs permissible in water which is delivered to 25 or more people, or 15 or more service connections. Other criteria that were used to assess the potential risk associated with the consumption of A-aquifer ground water include the proposed MCLs, MCLGs and the California State Action Levels Criteria which are designed to protect human health from chemical constituents in the drinking water. Table 4-6 summarizes the potential ARARs and other criteria established for drinking water.

The USEPA's Drinking water Health Advisories, in addition to MCL's and MCLG, also provide guidance for establishing drinking water quality standards. These advisories exist for 54 chemicals or chemical groups, seven of which are on the Jasco site indicator contaminant list (see Table 4-7). The exposure levels are established to migrate adverse health effects to the public. A safety factor has also been incorporated to protect sensitive population.

The definition for headings used for Table 4-7 follow:

- o One-day: Concentration calculation is based on 10-kg Child (one-year-old infant) consuming one liter of water per day.
- o Ten-day: Concentration calculation is based on a 10-kg child (one-year-old infant) consuming one liter of water per day.
- o Long Term: Concentrations are calculated for both 10-kg child concerning one liter of water per day and 70-kg adult consuming two liters of water per day.
- o Lifetime concentrations are calculated for a 70-kg adult consuming two liters of water per day.
- o Reference Concentrations for Potential Carcinogen. These concentrations indicate a risk of  $10^{-6}$ .

#### 4.6.2 ARARs for Air

The National Ambient Air Quality Standards (NAAQ) are the only regulations applicable to air contaminants at the Jasco site. The State of California provides no State specific ambient air quality criteria. It should be noted, however, that occupational exposure limits provided by the Occupational

TABLE 4-6  
POTENTIAL ARARS AND OTHER CRITERIA  
FOR CONTAMINANTS IN WATER

Indicator Contaminant	MCL(1) mg/l	MCLG(2) mg/l	CSAL(3) mg/l	Proposed MCL(1) mg/l	Proposed MCLG(2) mg/l
1,2 DCA	(4)	0	.001	.005	---
1,1 DCE	---	.007	.006	.007	---
TCE	---	0	.005	.005	---
Vinyl Chloride	---	0	.002	.001	---
Benzene	---	0	.0007	.005	---
Tetrachloroethylene	---	---	.004	---	0
Methylene Chloride	---	---	.040	---	---
1,1 DCA	---	---	.020	---	---
PCP	---	---	.0022	---	0.22

1. Maximum Contaminant Limits by the Federal Safe Drinking Water Act (USEPA 1986).
2. Maximum Contaminant Level Goal proposed by the USEPA (1986).
3. State Act Level, by the State of California, September 1987.
4. Not available.

TABLE 4-7  
EPA DRINKING WATER HEALTH ADVISORS

Indicator Contaminant	One-Day	Ten-Day	Long-Term		Life-Time	Reference Concentration for Potential Carcinogens(2)
	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>	<u>ug/l</u>
	Infant(3)	Infant(3)	Infant(3)	Adult	Adult	Adult
1,2 DCA	740	740	740	2600	N/A	0.95
1,1 DCE	1000	1000	1000	3500	---	0.24
TCE	---	---	---	---	---	2.8
Vinyl Chloride	2600	2600	13	46	N/A	0.015
Benzene	233	233	N/A	N/A	N/A	0.35
Tetrachloroethylene	---	34000	1940	6800	---	0.70
Methylene Chloride	13300	1500	---	---	---	5.0
1,1 DCA	---	---	---	---	---	---
PCP	1000	300	300	1050	220	---

1. Source: USEPA, 1985.

2. Values indicate a risk of  $10^{-6}$

3. 12 months.

Note: See text explanation for heading.



TABLE 4-8  
AIR STANDARDS (NON-ARARS)

Indicator Contaminant	PEL <sup>(1)</sup> mg/m <sup>3</sup>	TLV-TWA <sup>(2)</sup> mg/m <sup>3</sup>
1,2 DCA	---	40
1,1 DCE	---	20
TCE	270	270
Vinyl Chloride	---	10
Benzene	10	30
Tetrachlorethylene	170	335
Methylene Chloride	---	175
1,1 DCA	400	810
PCP	0.5	0.5

1. From: Occupational Safety and Health Administration, 1989.
2. From: American Conference of Governmental Industrial Hygienist, 1989.

Safety and Health Administration (OSHA) and the American Conferences of Governmental Industrial Hygienists (ACGIH) do exist. These exposure limits are calculated as Permissible Exposure Limits (PEL), as provided by OSHA or as Threshold Limit Value-Time Weighted Average (TLV-TWA) as provided by the ACGIH. Both values are exposure limits assuming an 8-hour work day with a 40-hour work week (see Table 4-8). These values are presented as possible reference levels only and do not imply ARAR status.

#### 4.6.3 ARARs for Soils

There are no Federal standards for contaminant levels in soils. The State of California, Department of Health Services has established Hazardous Waste Threshold Limit concentrations for some organic constituents including TCE and vinyl chloride. The toxicity criteria for these compounds are based on acute fish toxicity. The limits are called Soluble Threshold Limit Concentrations (STLCs) and Total Threshold Limit Concentrations (TTLCs). STLC and TTLC values for TCE and vinyl chloride are shown in Table 4-9. These values are presented as possible reference levels only and do not imply ARAR status.

#### 4.6.4 Results of Comparison

1,1 DCE exceeded or could be predicted to exceed the MCL standard in ground water (see Table 4-10). No potential ARARs were identified for the remaining seven indicator contaminants in ground water, soils or air. However, concentration levels of the seven indicator contaminants did exceed other criteria established by the State of California and the proposed MCL limits set by the USEPA.

TABLE 4-9  
SOIL STANDARDS (NON-ARARS)<sup>1</sup>

Contaminant	Soluble Threshold Limit Concentrations (mg/l)	Total Threshold Limit Concentration (mg/kg)
TCE	204	2040
Vinyl Chloride	NA <sup>2</sup>	10

- 
1. State of California, Department of Health Services, 1987.
  2. Not available.

TABLE 4-10  
EXPOSURE POINT CONCENTRATIONS VS POTENTIAL ARARS  
OR OTHER CRITERIA FOR CONTAMINANTS IN GROUND WATER

Indicator Contaminant	Potential ARARs (mg/l)	Other Critical(1) (mg/l)	Contaminant Concentration(2) (mg/l)	Standard Ratio
1,2 DCA	---	.001	0.17	170
1,1 DCE	.007	---	0.055	8
TCE	---	.005	0.96	192
Vinyl Chloride	---	.001	0.0031	3
Benzene	---	.0007	0.019	27
Tetrachloroethylene	---	.004	0.058	15
Methylene Chloride	---	.04	6.8	170
1,1 DCA	---	.02	0.2	10
PCP	---	.0022	0.0082	3.73

(1) Potential ARARs and other criteria listed in Table 4-6.  
(2) Average concentrations.

## SECTION 5.0

### HUMAN INTAKE ASSESSMENT

#### 5.1 Introduction

Since all indicator contaminant concentrations in ground water exceeded ARAR standards or other criteria limits, the risk characterization process was conducted for each exposure scenario. The concentration for the indicator contaminants at exposure points are used to calculate the exposure and intake levels for future land-use scenarios. The assessment of human intake is quantified in this section for those exposure events that were thought to be the most possible. These include the exposures that are likely to occur on a much more regular basis. The risk estimates for these most probable events were developed using a mathematical matrix that made provisions for a distribution of exposure and subsequent intake as a function of, for example, time activity and body weight.

This section describes the procedures used to determine human intake resulting from ingestion and inhalation exposure. Risks resulting from dermal intake are not calculated in this Endangerment Assessment because no methodologies are currently unavailable for inclusion with the intake estimates currently used.

The intake scenarios used in this section are representative of exposures assumed would occur on a repeating and regular basis. These include for example direct consumption of ground water at or in proximity of the Jasco site.

#### 5.2 Intake Calculation Assumptions

Estimating human intake exposure point concentrations required the development of a methodology that represents the variability of exposure. For each separate scenario specific assumptions applicable only to them were developed. However, in many cases standard assumptions common to all exposures and consequently intakes were used. In particular, the standard weights of 70 kilograms (154 pounds) for adults and 17 kilograms (38 pounds) for children were used. These standard assumptions were applied for exposure to both ground water and soils. Although there are currently several reviews taking place by the USEPA and the scientific community on the issue of actual values for body weight, the values stated above were used in view of the traditional consensus presented in USEPA methodology (USEPA 1986).

Similarly although a range of values exist for total daily water consumption by adults and children, the traditional approach under SPHEM and Superfund Exposure Assessment Manual (SEAM) guidance documents is to use two liters (.53 gallons) per day for adults and one liter (.27 gallons) per day for children. Although these values are conservative as direct consumption values, and lower values are more reasonable, a narrow range around these values was assumed to be more suitable for conditions present at the Jasco site.

The definition of short-term (subchronic exposure) and long-term (chronic exposure), as they pertain to discussion in this document are 10 to 90 days and 70 years, respectively. Those assumptions are documented in SPHEM (USEPA 1986). For the purpose of this Endangerment Assessment the 90 day duration was selected as the short-term duration. Given the exposure scenarios selected, this time period was considered likely to provide a more accurate estimate of exposure to the identified indicator contaminants at the characterized exposure points discussed in Section 4.0. It should also be noted that intakes for children were only calculated for the short-term period, and not for the lifetime 70 year period, as the duration of childhood is limited.

The emphasis of the methodology presented below was to take into consideration as much of the potentially explored population as possible and identify those intakes that could potentially result in clinical manifestations of toxicological end points. In order to do so assumptions were chosen to be conservative enough to include the 90th percentile of the population within the Jasco study area, as it would be unreasonable to predict that all of the population would fit the assumptions all of the time. The following sections predict the intake calculation assumptions specific to the exposure media, with scenario specific discussion.

### 5.2.1 Water Ingestion

The ingestion of water at the hypothetical residences using private wells completed within the contaminated A-aquifer is described in this section. The assumptions used in calculating ground water ingestion, as the sole source of drinking water, would average two liters per day as a consumption rate, for adults, and one liter per day for children (USEPA 1986). In addition, it was assumed that as both a best estimate and a maximum plausible value, 100 percent of the water consumption by children occurs at home. Adults were assumed to consume 80 percent of their water at home as a best estimate, and 100 percent as a maximum plausible value. These assumption were made because adults are likely to consume water both at home and away from home. Children were conservatively assumed to consume 100 percent of their water at home.

Since the source of ground water for this scenario is residential, it was reasonable to assume that every day of a short-term, 90-day period and a long-term 70 year (25,550 days) period, represented a day of ground water ingestion for adults.

### 5.2.2 Soil Ingestion

This section describes the assumptions that were used to calculate soil ingestion for the future land-use scenarios in which outdoor activities involve adult construction workers, adult residents engaged in yard work activities and children playing in areas where contaminated soils can be contacted.

There are many studies reporting a wide variety of soil ingestion rates. In general the range values are from 25 to 100 mg per day, as best estimate, up to 100 to 500 mg per day (LaGoy 1987). These values are highly dependent on age and activity. For this Endangerment Assessment values within these ranges were used to represent a reasonable approach.

The USEPA (1988) report average soil ingestion values for 3.5 to 5 year old children as 0.05 grams (50 mg) per day and 0.2 grams (200 mg) per day for 1.5 to 3.5 year old children. These values were used as best estimate and maximum plausible values, respectively, for soil ingestion. The value of 0.5 grams (500 mg) of soil ingested per day for adults was used as a maximum plausible value, this was based on an estimate of outdoor activity involving yard work at eight hours per day (Hawley 1985). A value of 0.2 grams (200 mg) per day was used as the best estimate.

The time of exposure varies with the individual scenarios. Studies by Hill (1985) have shown that outdoor work can range between approximately 15 to 26 hours per week for men and women,

therefore the resident that works the soil can be expected to work at least two days per week as a best estimate, and up to four days per week as a maximum plausible. These values were used in calculating time of exposure for soils to resident adults. It was assumed that children were exposed to soils for an equal number of days of outdoor activities. Short-term and long-term exposures for adults were assumed to be 90 days and 70 years, respectively.

During the redevelopment scenario, the potentially exposed persons are assumed to be construction workers who may encounter contaminated soils during redevelopment of the Jasco site and incidentally ingest 200mg (best estimate) to 500 mg (maximum plausible) of soil. Exposure time was conservatively assumed to be eight hours per day, five days per week for both best estimate and maximum plausible over a 90 day period of time. Longer exposures are not anticipated as excavation type activities for construction purposes are not prolonged.

### 5.2.3 Particulate Inhalation

The inhalation of airborne particulates was assumed to be limited to the future land-use scenarios where construction work is taking place, and/or tending and playing in a residential garden occurs. Air particulate concentrations were estimated based upon monitoring data collected at two residential construction sites in Arizona and Nevada (USEPA 1974). Although not site specific, this estimated value of  $0.29 \text{ mg/m}^3$  was considered a conservative estimate of the air particulate concentrations that an individual may encounter at the Jasco site. Of this  $0.29 \text{ mg/m}^3$  of particulate concentration, it was considered that 50 percent was respirable [particulate matter the size of 0.5 and 5.0 microns (Wedgman and Levy 1979)] as a best estimate, and 60 percent was respirable for a maximum plausible condition.

The inhalation rates of adults and children vary, depending on the level of activity. A moderate level of activity was assumed for construction workers and adults performing gardening activities. Therefore, adults were assumed to inhale at a rate of  $2.6 \text{ m}^3$  per hour as best estimate for the average adult (USEPA 1988), and  $2.8 \text{ m}^3$  per hour as a maximum plausible. This value was calculated by the USEPA (1988) for an adult male. Children were assumed to undergo heavy activity while playing outdoors and were assumed to inhale at a rate of  $2.4 \text{ m}^3$  per hour as best estimate, and  $4.2 \text{ m}^3$  per hour as maximum plausible value (USEPA 1988).

The best estimate exposure duration for adults was assumed to be eight hours per day, two days per week. Maximum plausible exposures for adults were assumed to be eight hours per day for four days per week. Children were assumed to be outdoors for 1.5 hours per week (best estimate) and 2.0 hours per week (maximum plausible) (Timmer et. al. 1985). Inhalation of particulates was assumed to occur



only half of the time over the 70 year period representing long-term exposure. This assumption accounts for periods of inactivity due to inclement weather, illness, and any other reason that would preclude outdoor activities. As a conservative estimate it was assumed that short-term exposure to particulate contaminants occurs at every occurrence of outdoor activity. This assumption could be considered reasonable as the short-term 90 day exposure duration can represent the summer months when outdoor activities are frequent.

Both best estimate and maximum plausible exposure durations for construction workers were assumed to be eight hours per day, five days per week. Exposure is expected to be of only short-term duration (90 days), as construction activities are not for extended periods of time.

#### 5.2.4 Inhalation of Vapors While Showering

This section describes the assumptions used to calculate inhalation of volatilized contaminants while showering. This is applicable to the future land-use scenario in which ground water is the source of residential potable water. For the purpose of this Endangerment Assessment showering activities were limited to adults.

As stated in Section 5.2.3 inhalation rates are dependent upon the level of activity of an individual. A light level of activity resulting in an inhalation rate of  $1.3 \text{ m}^3$  per hour (USEPA 1988) was assumed for adults while showering. This rate was considered as both a best estimate and maximum plausible value since it was assumed that a light activity level is representative of showering for the entire exposed population.

Studies by Hill (1985) have shown that showering activities can range from 0.5 hours per week (five minutes per day), to 1.2 hours per week (10 minutes per day). These values were used for both best estimate and maximum plausible exposure durations. It was also assumed that showering occurs every day for both short-term and long-term periods.

As a conservative estimate it was calculated that 100 percent of the ground water contaminants are available for inhalation intake during the showering scenario.

#### 5.2.5 Dermal Exposure to Soils

Dermal exposure was assumed to occur in the same intake scenarios as discussed in soil ingestion and particulate inhalation sections. Intakes and subsequent risks resulting from dermal intake were not

calculated in this Endangerment Assessment, due to the lack of acceptable methodology for the determination of risks due to dermal exposures.

#### 5.2.6 Dermal Exposure to Water

The dermal exposure to ground water was assumed to occur in the future land-use scenario when ground water is used for showering. Dermal intakes were not calculated for those reasons stated previously in Section 5.2.5.

#### 5.2.7 Inhalation of Vapors, Outside of Residence

Inhalation of contaminants from the volatilization of volatile organic compounds in the soils was assumed to occur in the future land-use scenario in which outdoor activities involve the construction workers, adults, and children.

A highly conservative screening analysis was conducted to determine the potential health risk associated with inhalation exposure from the volatilization of the indicator contaminants in the soils. This analysis is presented in Appendix D and shows that the exposure to air emissions resulting from the volatilization of contaminants of the soils would not pose a significant health risk to the surrounding residents and worker population. The total upper-bound incremental lifetime risk at the point of maximum concentration was calculated to be  $5.8 \times 10^{-7}$  which is at the upper-bound limit of the carcinogenic risk range established by USEPA.

### 5.3 Intake Analysis

The calculation of intake (mg/kg/day) was completed for both subchronic (90 days) and chronic (70 years) scenarios. The receptor-specific intake rates are presented in Tables D-1 through D-9 in Appendix D. Each table presents the intake rate of a specific contaminant via a specific medium for adult residents, construction workers or children. The calculation of both best estimate and maximum plausible intake rates was completed using the set of parameters described in the preceeding sections. Comparison of these calculations show that the largest oral and inhalation intake value for contaminants is via ground water ingestion by adults and children.

## SECTION 6.0

### RISK CHARACTERIZATION

#### 6.1 Introduction

This section describes the potential health risks associated with the exposure scenarios developed during the exposure assessment. To characterize the potential risks associated with the Jasco site, the exposure scenarios are integrated with the results of the toxicity assessment.

The potential risks associated with the indicator contaminants were quantified by using the short-term (subchronic) and long-term (chronic) daily contaminant intake. Intake amounts were then compared to published acceptable chronic and subchronic daily intake levels to assess potential non-carcinogenic health effects. Potential lifetime cancer risks were derived by using published carcinogenic potency factors.

In some cases the indicator contaminants exert carcinogenic effects that are of greater concern than the non-carcinogenic effects, or the carcinogenic effects are so severe that research has not substantially differentiated between the two effects when this is the case (e.g. 1,2-Dichloroethane, Benzene, Trichloroethane, and Vinyl Chloride) the Endangerment Assessment addressed the more significant carcinogenic effect. In other cases where research has been able to substantially characterize non-carcinogenic effects and carcinogenic effects for indicator contaminants (e.g. 1,1-Dichloroethene, Methylene Chloride, and Tetrachloroethylene) both non-carcinogenic and carcinogenic risks were calculated. By this rationale, the Endangerment Assessment characterizes non-carcinogenic and carcinogenic risks to the furthest and most practical level available based on the known scientific evidence as presented in the toxicological profiles.

#### 6.2 Non-Carcinogenic Risk Assessment Methodology

For non-carcinogens, the U.S. EPA has calculated acceptable daily intakes for both short and long term. Since short-term (sub-chronic) exposure to relatively high concentrations of chemical contaminants can cause different toxic effects than those caused by long-term (chronic) exposure to lower concentrations, two intake levels are calculated for each chemical, the sub-chronic acceptable intake (AIS) and the chronic acceptable intake (AIC). The acceptable daily intakes are specific to exposure routes, oral and inhalation, and are expressed in mg/kg/day. Acceptable daily intake levels for indicator contaminants used in this assessment were determined by using the USEPA Integrated

Risk Information System (IRIS) (USEPA 1989), and through the aid of Region IX EPA (USEPA 1989a). A summary of oral and inhalation AIs and AICs are listed in Table 6-1.

Once the acceptable reference intake was determined, the hazard indices (HI) were determined by dividing the appropriate calculated intake levels by the appropriate acceptable intake reference level. This comparison results in a ratio of **estimated intake:acceptable intake**. Any chemical with an intake level greater than the acceptable intake levels will cause the HI to exceed unity. When an HI exceeds unity there may be a concern for potential health risks (USEPA 1986). These health risks are discussed in the detailed chemical-specific Toxicological Profiles presented in appendix B. Total hazard indices are based upon the comprehensive levels that may be incurred by an individual. Total hazard indices are calculated by adding the chemical-specific hazard indices together.

### 6.3 Carcinogenic Risk Assessment Methodology

Carcinogenic Risks were calculated for indicator contaminants that have been identified as being potential human carcinogens. This identification process has been performed by the USEPA and is based on current toxicological/epidemiological evidence.

Carcinogenic risk calculations were performed by using individual long-term intake levels of indicator contaminants for both best estimate and maximum plausible, and multiplying them by the appropriate chemical-specific carcinogenic potency factor (CPFs) presented in Table 6-2. The CPF anticipates the probability of occurrence of a lethal cancer within a lifetime and is expressed in units of  $(\text{mg}/\text{kg}_{\text{bodyweight}}/\text{day})^{-1}$ . This factor is an upper 95 percent confidence limit on probability of response per unit intake of a chemical over a lifetime. Therefore there is only a five percent chance that the probability of a response could be greater than the estimated value on the basis of experimental data used. If the exposure assessment is conservative, the predicted risk is an upper bound estimate. Consequently, the predicted risk may overestimate the actual risk at a site. However, this method is used so that the carcinogenic risk will be underestimated (USEPA 1986).

The resulting product of the  $\text{CPF} \times \text{intake}$  is a numerical expression that estimates the excess cancer mortality rate to a population due to intake of a carcinogenic contaminant over a 70 year period. For example, the expression  $1 \times 10^{-6}$  illustrates a potential excess cancer rate to a population to be one in a million attributed to the chemical in question over a 70 year period. The USEPA recognizes an allowable range of carcinogenic risk of  $10^{-4}$  to  $10^{-7}$  after remediation (USEPA 1986).

TABLE 6-1  
ACCEPTABLE DAILY INTAKE FOR  
INDICATOR CONTAMINANTS  
(NON-CARCINOGENIC EFFECTS)

Indicator Contaminant	<u>Oral</u>		<u>Inhalation</u>	
	AIS(1) mg/kg/day	AIC(2) mg/kg/day	AIS(1) mg/kg/day	AIC(2) mg/kg/day
1,2 DCA	---	---	---	---
1,1 DCE	$9.00 \times 10^{-3}$	$9.00 \times 10^{-3}$	---	---
TCE	---	---	---	---
Vinyl Chloride	---	---	---	---
Benzene	---	---	---	---
Tetrachloroethylene	$1.0 \times 10^{-2}$	$1.0 \times 10^{-2}$	---	---
Methylene Chloride	$6.0 \times 10^{-2}$	$6.0 \times 10^{-2}$	$9.0 \times 10^{-1}$	$9.0 \times 10^{-1}$
1,1 DCA	1.0	$1.0 \times 10^{-1}$	1.0	$1.0 \times 10^{-1}$
PCP	$3.0 \times 10^{-2}$	$3.0 \times 10^{-2}$	---	---

- (1) Acceptable subchronic daily intake.  
(2) Acceptable chronic daily intake.

TABLE 6-2  
CARCINOGENIC POTENCY FACTORS FOR  
INDICATOR CONTAMINANTS  
(CARCINOGENS)

Indicator Contaminant	Oral Potency Factor mg/kg/day <sup>-1</sup>	Inhalation Potency Factor mg/kg/day <sup>-1</sup>	Source
1,2 DCA	$9.1 \times 10^{-2}$	$9.10 \times 10^{-2}$	USEPA 1989
1,1 DCE	$6.0 \times 10^{-1}$	1.20	USEPA 1989
TCE	$1.1 \times 10^{-2}$	$1.30 \times 10^{-2}$	USEPA 1989a
Vinyl Chloride	2.30	$2.95 \times 10^{-1}$	USEPA 1989a
Benzene	$2.9 \times 10^{-2}$	$2.90 \times 10^{-2}$	USEPA 1989
Tetrachloroethylene	$5.1 \times 10^{-2}$	$3.30 \times 10^{-3}$	USEPA 1989a
Methylene Chloride	$7.5 \times 10^{-3}$	$1.40 \times 10^{-2}$	USEPA 1989
1,1 DCA	$9.1 \times 10^{-2}$	---	USEPA 1989a
PCP	$1.6 \times 10^{-2}$	---	USEPA 1989a

## 6.4 Risk Analysis

This section evaluates the risk to human health that is posed by the Jasco site. Scientific judgement was used to select best estimate values that probably represent actual intakes at and near the Jasco site and maximum plausible intakes that are based on intake estimates that may occur, but are not necessarily representative of conditions associated with the site. As previously stated complete exposure pathways under current land-use conditions do not exist. Therefore health risks associated with current land-use scenario were not calculated. Potential health risks associated with the projected future land-use scenario (residential occupancy) were calculated and are discussed in the following sections.

### 6.4.1 Ground Water

The possibility that a small domestic well would be drilled into the A-aquifer for a water supply is very small. The ground water is regulated by the Santa Clara Valley Water District with a fee for ground water withdrawal and neither the A or B-aquifer are currently used for domestic purposes in the vicinity of the Jasco site. A summary of results shown on Table E-1 demonstrates that the chronic hazard indices associated with ground water ingestion by adult residents exceeds unity ( $HI_{\text{Best Estimate}} = 3.2$  and  $HI_{\text{Maximum Plausible}} = 3.7$ ). Further analysis of the chemical specific hazard indices reveals that methylene chloride ( $HI_{\text{Best Estimate}} = 3.0$  and  $HI_{\text{Maximum Plausible}} = 3.3$ ) is the main contaminant responsible for the high hazard index calculated for ground water ingestion by adult residents. Subchronic hazard indices for ground water ingestion by adults (see Table E-2) and children (see Table E-3) are less than one and no adverse effects would be expected to occur.

Chronic and subchronic hazard indices associated with inhalation of vapors while showering by adults are presented in Tables E-4 and E-5. Calculations indicate chronic hazard indices are less than one for both best estimate and maximum plausible values. Subchronic hazard indices were found to be 1.2 (best estimate) and 3.0 (maximum plausible). These excessive hazard indices are due to estimated methylene chloride intakes.

Potential excess cancer risks associated with consuming ground water containing carcinogenic indicator contaminants are shown on Table E-6. Calculations indicate a range from  $3.4 \times 10^{-6}$  for pentachlorophenol (PCP) to  $1.4 \times 10^{-3}$  for methylene chloride as best estimate, and  $3.8 \times 10^{-6}$  for

PCP and  $1.5 \times 10^{-3}$  for methylene chloride for maximum plausible values. Cumulative carcinogenic risks associated with ground water ingestion are  $3.6 \times 10^{-3}$  for Best Estimate and  $4.0 \times 10^{-3}$  Maximum Plausible values. Calculation of lifetime cancer risks associated with inhalation of vapor by adults while showering are presented in Table E-7 and show potential excess cancer risk of  $2.7 \times 10^{-4}$  for best estimate and  $5.9 \times 10^{-4}$  maximum plausible values. Methylene chloride presents the highest potential cancer risk for both best estimate and maximum plausible values with potential risks of  $1.0 \times 10^{-4}$  and  $2.9 \times 10^{-4}$  respectively.

#### 6.4.2 Soils

Potential exposure to contaminated soils via incidental ingestion and fugitive dust inhalation by construction workers may occur as a result of on-site construction activities during redevelopment of the Jasco property. On-site residents including children may also become exposed to contaminated soils during gardening activities and playing. The likelihood of the above scenarios being carried out is highly probable since the area surrounding the site is residential and the site property was rezoned residential in 1983 and Jasco is required to vacate the premises by 1992.

Chronic and subchronic hazard indices for contaminated soil ingestion by on-site adult residents are presented in Tables E-8, and E-9. Subchronic hazard indices for children and construction workers are shown in Table E-10 and E-11, respectively. Calculations demonstrate that cumulative hazard indices for all receptors are much less than unity and therefore toxic effects are assumed to be negligible. Cumulative potential excess cancer risks presented by ingestion of contaminated soils by adults are shown on Table E-12 and indicate potential excess cancer risks of  $7.3 \times 10^{-7}$  and  $3.7 \times 10^{-6}$  for best estimate and maximum plausible values, respectively.

Hazard indices for chronic and subchronic fugitive dust inhalation by on-site residents are presented in Tables E-13 and E-14. Subchronic hazard indices associated with fugitive inhalation by children and construction workers are shown in Table E-15 and E-16, respectively. Results indicate that all hazard indices values are substantially less than unity for all receptors and therefore potential non-carcinogenic health risks associated with exposure to contaminated fugitive dust. Therefore no adverse health effect would be expected. Cumulative potential cancer risks associated with inhalation of contaminated fugitive dust by adults are presented in Table E-17 and show potential cancer risk of  $6.5 \times 10^{-9}$  for best estimate and  $1.7 \times 10^{-8}$  for maximum plausible values.



### 6.4.3 Conclusion

Chronic and subchronic hazard indices were calculated for total daily ingestion of indicator contaminants via ingestion of ground water combined with incidental ingestion of contaminated soils by adults (see Table E-18). Chronic hazard indices for total daily ingestion exceed unity with 3.4 for best estimate and 3.7 for maximum plausible values. Comparison to hazard indices calculated for ground water ingestion (Table E-1) and soil ingestion, (Table E-8) shows that ground water ingestion in particular the ingestion of the contaminant methylene chloride, poses the adverse health effects associated with chronic ingestion of indicator contaminants. Subchronic hazard indices for total daily ingestion of indicator contaminants are less than one for both best estimate and maximum plausible values. Therefore no adverse health effects would be expected.

Chronic and subchronic hazard indices for total daily inhalation of indicator contaminants by way of inhalation of vapors while showering combined with inhalation of contaminated fugitive dust by adults are shown on Table E-19. Calculations indicate hazard indices of less than one for both chronic and subchronic intake values and therefore adverse health effects would be assumed to be negligible.

Table E-20 presents a summary of subchronic hazard indices calculated for total daily ingestion (ingestion of both ground water and contaminated soils) and total daily inhalation (inhalation of contaminated fugitive dust) of indicator contaminants by children. Results indicate that through ingestion hazard indices are substantially greater than one for both best estimate and maximum plausible values. These excessive hazard indices result from the consumption of contaminated ground water by a 17 kg child. Contaminant specific analysis indicates that the intake of methylene chloride under the best estimate assumptions is 6.7. All other best estimate hazard indices are below unity. For the maximum plausible intake assumptions, 1,1-DCE, tetrachloroethylene, and methylene chloride, all have hazard indices substantially excessive of unity (21, 25, and 850 respectively).

Subchronic hazard indices for total daily ingestion (ingestion of contaminated soils) and total daily inhalation (inhalation of fugitive dust) by construction workers are summarized in Table E-21. Calculations indicate hazard indices of considerably less than one for both exposure pathways. Therefore no adverse health effects would be expected from exposure to either pathway.

Table E-22 includes a summary of the potential lifetime cancer risks associated with total daily ingestion. Total daily ingestion includes ground water ingestion combined with soil ingestion. Results show potential lifetime cancer risks of  $3.7 \times 10^{-3}$  for best estimate and  $4.1 \times 10^{-3}$  for maximum plausible values. When potential lifetime cancer risks for total daily ingestion are compared to

potential cancer risks calculated for ground water ingestion (Table E-16) and soil ingestion (Table E-12) it is evident that ingestion of ground water poses the greatest potential lifetime cancer risks.

Potential lifetime cancer risks associated with total daily inhalation of indicator contaminants are also included on Table E-22. Total daily inhalation includes inhalation of vapors while showering combined with inhalation of fugitive dust. Calculations indicate potential lifetime cancer risks of  $2.5 \times 10^{-4}$  for best estimate  $6.4 \times 10^{-4}$  for maximum plausible values. Comparison between the calculated potential lifetime cancer risks associated with total daily inhalation of indicator contaminants to individual potential cancer risks calculated for inhalation of vapors (Table E-7) and inhalation of fugitive dust (Table E-17) shows that the potential cancer risk associated with inhalation of fugitive dust is minimal as compared to inhalation of vapors while showering.

## SECTION 7.0

### CONCLUSIONS

This section presents the conclusions of the Endangerment Assessment which are listed below. It was determined that the only complete exposure pathway associated with current land-use of the Jasco site was employee and trespasser exposure via inhalation of volatilized contaminants originating in the soils. A screening analysis, using a worse-case scenario indicates a potential carcinogenic risk of  $5.8 \times 10^{-7}$  which is within the USEPA allowable carcinogenic risk range of  $10^{-4}$  to  $10^{-7}$  after remediation.

Separate estimates of the potential for carcinogenic risk and non-carcinogenic risk were calculated for each exposure scenario associated with potential future land-use (residential occupancy) of the site. Risk calculations were made for representative concentrations (best estimate) of the contaminants and for the highest measured contaminant concentrations (maximum plausible). As a result each scenario is associated with four risk calculations: best estimate - carcinogenic; maximum plausible - carcinogenic; best estimate - non-carcinogenic; maximum plausible - non-carcinogenic. The findings were as follows.

- 1) Significant carcinogenic risks were calculated for both best estimate and maximum plausible values associated with ground water (A-aquifer) consumption and inhalation of ground water vapors.
- 2) Significant non-carcinogenic risks were calculated for ground water ingestion using best estimate and maximum plausible contaminant concentration levels.
- 3) There is no significant carcinogenic risk or non-carcinogenic risk associated with exposure to on-site contaminated soils via incidental ingestion or fugitive dust inhalation.

The risk characterization step focused upon human health effects and risks due to the chemical properties of each of the indicator contaminants considered. The results of the risk characterization process were expressed in hazard indices for non-carcinogenic effects and risk levels for carcinogenic effects. For this assessment a hazard index exceeding unity and a risk level exceeding  $1 \times 10^{-6}$  was considered to pose a potential health threat.

Best estimate and maximum plausible hazard indices indicate that chronic and subchronic health effects are not expected as a result to exposure to media containing indicator contaminants for inhalation and ingestion pathways except for chronic daily ingestion of ground water.

The carcinogenic risks were estimated by considering those contaminants for which carcinogenic potency factors have been developed. Under these conditions best estimate carcinogenic risks of greater than  $1 \times 10^{-6}$  were calculated for ground water ingestion ( $3.6 \times 10^{-3}$ ) and ground water vapor inhalation ( $2.7 \times 10^{-4}$ ) scenarios.

For ground water ingestion and inhalation pathways it is important to point out that the non-carcinogenic risk and carcinogenic risk are largely dependent upon the concentration of methylene chloride in the water.

The uncertainties associated with the risks at the Jasco site relate to the procedures and inputs used in the assessment. Uncertainties can result from the use of conservative assumptions which is often the case in exposure assessments where data is lacking. Assumptions made in the process of developing the Endangerment Assessment are noted within the report and have resulted in areas of uncertainty. The identified uncertainties are as follows.

- 1) The results generated by the ground water modeling are based on limited field data without adequate field data describing the subsurface system models cannot predict exposure point concentrations with complete accuracy. In light of these difficulties assumptions were made to evaluate contaminant migration and exposure point concentrations. The application of these assumptions resulted in conservative estimates of exposure point concentrations and subsequent risk estimates.
- 2) The use of the highest recorded contaminant data as exposure point concentrations is another area of uncertainty. It is unlikely that high value data realistically represents the concentration that will be encountered by the public.
- 3) The potential difference between detection limit values used in the assessment and the actual contaminant data is another source of uncertainty that effects the conclusion that a significant risk exist.
- 4) Additional conservativeness is associated with the derivation of critical toxicity values from a limited number of study results (i.e. data extrapolated from animal studies to predict potential health effects of a chemical in human).

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APPENDIX D

DERIVATION OF SOIL CLEANUP  
STANDARDS

**PRC** Environmental Management, Inc.  
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## **TECHNICAL MEMORANDUM**

**DATE:** May 18, 1992  
**TO:** Rose Marie Caraway  
**FROM:** Xuannya Pham-Mahini  
**SUBJECT:** Baseline Risk Estimation and Derivation of Health-based Standards for the Contaminated Soils at the Jasco Superfund Site  
**CONTRACT No.:** 68-W9-0009  
**WA No:** C09032

### **1.0 INTRODUCTION**

The Jasco Superfund Site is located in a residential zoning area in the city of Mountain View, California. Since 1976, Jasco's production process involves repackaging of bulk chemicals into small containers and blending of chemicals to produce proprietary products. Large amounts of different types of solvents and fuels have been stored in tankers at the site. Previous investigations revealed that the soil and ground water underlying the site are contaminated with chemicals known to be used or stored at the Jasco facility. These contaminants are mainly petroleum hydrocarbon mixtures (diesel fuel, kerosene, and paint thinner) and volatile organic compounds (VOC), such as alcohols (ethanol, isopropanol, and methanol), aromatics [benzene, toluene, ethylbenzene, and xylenes (BTEX)], halogenated aliphatics (methylene chloride, tetrachloroethene, trichloroethene, and others), and their degradation products. Existing endangerment assessment results indicate that direct exposure to the contaminants in the soil pose insignificant risks (a cumulative excess cancer risk of less than  $1E-04$  and a cumulative hazard index of less than 1) [Jacobs Engineering Group (JEG), 1989] and will not be considered further in deriving soil cleanup levels. However, the threat to the underlying aquifers

may exist via soil leaching, and therefore, soil cleanup levels should be based on the potential contaminant migration to the ground water.

Work Assignment No. C09032, which the U.S. Environmental Protection Agency (EPA) issued to PRC Environmental Management, Inc. (PRC), calls for various technical enforcement support. A portion of this support involves risk assessment and related activities. In particular, EPA has asked PRC to accomplish the following tasks:

- Determine the preliminary health-based standards (HBS) (or cleanup levels) for chemicals of potential concern (COPC) in the soils based on the potential for the COPCs to migrate to the underlying ground water.
- Select a final HBS for each chemical to be the most health-protective value based on either carcinogenic or noncarcinogenic effects.
- Determine the preliminary selected cleanup standards (SCS) for the COPCs in the soils using either the federal or state maximum contaminant levels (MCL) or the final HBSs for the ground water.
- Estimate the baseline cumulative carcinogenic risk and noncarcinogenic hazard posed by the COPCs in the soils (via the ground-water pathway) and ground water, assuming that the ground water is being used for potable and domestic purpose.
- Derive the final soil SCSs for these COPCs based on cumulative health effects of exposure to multiple chemicals.

PRC completed these tasks and the results are reported in this technical memorandum. The memorandum is divided into five sections: (1) Introduction; (2) Health-Based Standards and Selected Cleanup Standards (Tables 1 through 5); (3) Baseline Cumulative Health Risks (Tables 6 and 7); (4) Final Selected Cleanup Standards for Soil (Tables 8 and 9); and (5) Summary.

## **2.0 HEALTH-BASED STANDARDS AND SELECTED CLEANUP STANDARDS**

In this section, the HBSs and preliminary SCSs for COPCs in the soils at the Jasco site were developed based on the potential contaminant migration to the underlying ground water and under the

assumption that the ground water is being used for potable and domestic purposes. This section includes four subsections as follows:

- Terminology.
- Selection of chemicals of potential concern.
- Health-based standards
- Preliminary selected cleanup standards.

### Terminology

The principal terms used in this technical memorandum are defined as follows:

- **HBS:** The cleanup standard, based on either a target carcinogenic risk or noncarcinogenic hazard index, that is protective of the exposed populations. HBSs for ground water ( $HBS_{gw}$ ) are derived under the assumption that the underlying ground water is used for potable and domestic purposes. The HBSs for soil ( $HBS_s$ ) are calculated using the  $HBS_{gw}$  and the Summer's leachate model.
- **SCS:** The cleanup standard selected by EPA risk managers. For the ground water, the  $SCS_{gw}$  is either the federal/state MCLs or  $HBS_{gw}$ . For soil, the SCS ( $SCS_s$ ) is calculated using the  $SCS_{gw}$  and the Summer's leachate model.
- **Preliminary (cleanup standard):** Preliminary cleanup standard for a chemical designates an individual standard based on a target carcinogenic risk or a target noncarcinogenic hazard. Each chemical may have up to two preliminary cleanup standards, one each for carcinogenic and noncarcinogenic effects.
- **Final (cleanup standard):** Final cleanup standard for a chemical designates an individual standard selected from preliminary cleanup standards. If a chemical has two preliminary standards based on both carcinogenic and noncarcinogenic effects, the most stringent value will be chosen as the final cleanup standard. Final cleanup standards also may be adjusted to take into account exposure to multiple chemicals.

### Chemicals of Potential Concern

The list of COPCs considered in this technical memorandum was compiled based on information presented in the endangerment assessment (JEG, 1989) and feasibility study (JEG, 1992)

reports for the Jasco site. All of the contaminants detected in the ground water at the site are considered COPCs: acetone, benzene, chloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene (assuming cis- for health protective purpose), ethyl benzene, methylene chloride, methyl ethyl ketone, pentachlorophenol, tetrachloroethene, toluene, 1,1,1-trichloroethane, trichloroethene, vinyl chloride, and xylenes. Among these compounds, chloroethane, methyl ethyl ketone, and vinyl chloride were not detected in the soil.

In addition, there are eight chemicals and total petroleum hydrocarbon (TPH) mixtures that were detected in the soil, but not reported for the ground water (JEG, 1992). These are as follows: bromoform, diesel fuel, ethanol, isopropanol, kerosene, methanol, paint thinner, 2-propanone, and other low to high boiling point TPH mixtures. For the purpose of this analysis, bromoform was not added to the COPC list due to its low concentration in the soil. Ethanol, isopropanol, and 2-propanone were not considered because there are no available toxicity values for these substances; in addition, they are considered innocuous to human receptors following environmental exposures at low concentrations. Most of the TPHs detected have low to medium boiling point. The low boiling point TPHs, such as paint thinner or gasoline mixture, are volatile and usually have high VOC levels. The medium boiling point TPHs, such as diesel fuel or kerosene (middle distillate products), are semivolatile and have lower VOC levels. Because the toxic VOC components of TPHs were also addressed in this analysis, for health protective purposes, diesel fuel or kerosene was considered as a surrogate mixture for all TPHs found at the site. Consequently, only methanol and the diesel fuel or kerosene surrogate mixture were added to the COPC list.

### Health-Based Standards

The preliminary  $HBS_{\text{sl}}$  for contaminants in the soil, in milligrams per kilogram (mg/Kg), at the Jasco site were developed based on the assumption that the underlying ground water will be used for potable and domestic purposes. First, the preliminary  $HBS_{\text{gw}}$  for contaminants in the ground water, in milligrams/liter (mg/L) were developed based on the on-site reasonable maximum exposure (RME) residential scenario (EPA, 1989b; 1991b). Then, the  $HBS_{\text{sl}}$  were estimated using the  $HBS_{\text{gw}}$  and the Summer's leachate model (EPA, 1989a).

The pertinent ground-water exposure pathways contributing the most to the total risk were the direct ingestion and inhalation of VOCs volatilized from water during domestic usage. The dermal contact aspect of the ground-water pathway during showering was not evaluated because VOCs are expected to be readily volatilized before being absorbed through the skin. The inhalation of VOCs from water is considered only for volatile chemicals with a Henry's Law Constant of  $1 \times 10^{-5}$  atmosphere-cubic meter per mole ( $\text{atm}\cdot\text{m}^3/\text{mol}$ ) or greater and a molecular weight (MW) of less than 200 grams per mole ( $\text{g/mol}$ ). Therefore, the inhalation pathway was not considered for pentachlorophenol and the diesel fuel or kerosene surrogate mixture, which are semivolatiles. Therefore, the following equation was used:

$$\text{Total Water Risk} = \text{Risk (Ingestion + VOC Inhalation)} \quad (2-1)$$

For COPCs that have both carcinogenic and noncarcinogenic toxicity values, separate  $\text{HBS}_{\text{gw}}$  were derived based on both types of health effects. The risk levels of concern are an excess cancer risk of one in a million ( $1\text{E-}06$  or  $10^{-6}$ ) for carcinogenic effects and a hazard index (HI) of 1 for noncarcinogenic effects. The route-specific toxicity values such as slope factors (SF) and chronic reference doses (RfD) for the COPCs are listed in Tables 1 and 2, respectively. Expressed in unit of  $(\text{milligrams/kilogram}\cdot\text{day})^{-1}$ , or  $(\text{mg/Kg}\cdot\text{d})^{-1}$ , the slope factor is the upperbound confidence limit of the slope of the linearized multistage model that expresses excess cancer risk as a function of exposure. The chronic reference dose, in unit of  $\text{mg/Kg}\cdot\text{d}$ , is the estimated daily intake for a chemical, normalized by body weight, that is expected to pose no appreciable risk of deleterious systemic effects to humans (including sensitive subpopulations) after an exposure event (developmental), during a portion of a lifetime (subchronic) or over a lifetime (chronic).

$\text{HBS}_{\text{gw}}$  calculations are based on EPA guidance (EPA, 1989b; 1991b) and EPA-recommended standard exposure default factors (EPA, 1991d). The equations used in calculating the  $\text{HBS}_{\text{gw}}$  are presented below (EPA, 1991b).

#### Carcinogenic Effects

$$\text{HBS}_{\text{gw}} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365 \text{ days/yr}}{\text{EF} \times \text{ED} \times [(\text{SF}_o \times \text{IR}_w) + (\text{SF}_i \times \text{IR}_a \times \text{K})]} \quad (2-2)$$

(mg/L)



**TABLE 1**  
**SLOPE FACTORS FOR CARCINOGENIC EFFECTS OF CHEMICALS OF POTENTIAL CONCERN**

CHEMICAL NAME	CAS No.	SLOPE FACTOR 1/(mg/Kg-d)		WEIGHT-OF- EVIDENCE (a)	TYPE OF CANCER (Oral/Inhalation)	SF BASIS (Oral/Inhal.)	SF SOURCE (Oral/Inhal.) (b)	COMMENTS
		Oral	Inhalation					
Acetone	67-64-1	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
Benzene (c)	71-43-2	2.9E-02	2.9E-02	A	Leukemia/Leukemia	Gavage/Inhal.	IRIS/IRIS	
Chloroethane	75-00-3	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
1,1-Dichloroethane	75-34-3	9.1E-02	ND	C	Hemangiosarcoma/NA	Gavage/NA	HEAST (g)/IRIS	No SF in current IRIS/HEAST
1,1-Dichloroethene (c,f)	75-35-4	6.0E-01	1.8E-01	C	Adrenal/Kidney	Inhal./Inhal.	IRIS/IRIS	
1,2-Dichloroethane (c)	107-06-2	9.1E-02	9.1E-02	B2	Circulatory/Circulatory	Gavage/Gavage	IRIS/IRIS	
cis-1,2-Dichloroethene	156-59-2	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
Diesel fuel or kerosene mixture	---	NA	NA	---	NA/NA	NA/NA	PRC (h)	
Ethylbenzene	100-41-4	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
Methanol	67-56-1	NA	NA	D	NA/NA	NA/NA	HEAST/HEAST	No SF in HEAST
Methylene chloride (c)	75-09-2	7.5E-03	1.6E-03	B2	Liver/Lung, liver	Water/Inhal.	IRIS/IRIS	
Methyl ethyl ketone	78-93-3	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
Pentachlorophenol	87-86-5	1.2E-01	NA	B2	Liver, adrenal, circulatory/NA	Diet/NA	IRIS/IRIS	
Tetrachloroethene (d)	127-18-4	5.1E-02	1.8E-03	B2	Liver/Liver, leukemia	Gavage/Inhal	HEAST/HEAST	
Toluene	108-88-3	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
1,1,1-Trichloroethane	71-55-6	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST
Trichloroethene (c,f)	79-01-6	1.1E-02	5.6E-03	B2	Liver/Lung	Oral/Inhal.	HEAST/HEAST	
Vinyl chloride (d)	75-01-4	1.9E+00	2.9E-01	A	Liver/Liver	Diet/inhal	HEAST/HEAST	
Xylenes (mixed)	1330-20-7	NA	NA	D	NA/NA	NA/NA	IRIS/IRIS	No SF in IRIS or HEAST

NOTES: CAS -- Chemical Abstract Service; SF -- Slope factor; NA -- Not available or not applicable; ND -- Not determined.

(a) The EPA classification system for weight-of-evidence: A = Human carcinogen; B1 = Probable human carcinogen, limited evidence in humans; B2 = Probable human carcinogen, sufficient evidence in animals and inadequate or no evidence in humans; C = Possible human carcinogen; D = Not classifiable as to human carcinogenicity; E = Evidence of noncarcinogenicity for humans.

(b) IRIS= Integrated Risk Information System (EPA, 1992); HEAST = Health Effects Assessment Summary Tables, Annual FY-1991, January 1991 (EPA, 1991a).

(c) Inhalation slope factor was derived from inhalation unit risk (m3/ug) by multiplying by a body weight of 70 kg and a conversion factor of 1E+03 ug/mg and dividing by an inhalation rate of 20 m3/day.

(d) IRIS: Carcinogenic assessment is currently pending (EPA, 1992).

(e) IRIS: Carcinogenic assessment was withdrawn on 07/01/89 (EPA, 1992).

(f) Inhalation SF based on metabolized doses was adjusted for administered doses (EPA, 1991a).

(g) HEAST (1990) = Health Effects Assessment Summary Tables, First/Second Quarters, FY - 1990.

(h) Reference: Underground Storage Tank Characterization at the U.S. Army Reserve Center Site, Fort Shafter Flats, Hawaii - Preliminary Risk Assessment (PRC, 1992).

**TABLE 2**  
**CHRONIC ORAL AND INHALATION REFERENCE DOSES FOR NONCARCINOGENIC EFFECTS OF CHEMICALS OF POTENTIAL CONCERN**

CHEMICAL NAME	CAS No.	Reference Dose (RfD) (mg/Kg-d)		Confidence Level (Oral RfD)	CRITICAL EFFECT (Oral/Inhalation)	RfD BASIS (Oral/Inhal.)	RfD SOURCE (Oral/Inhal.) (a)	UNCERTAINTY AND MODIFYING FACTORS Oral/Inhalation (b)
		Oral	Inhalation					
Acetone	67-64-1	1E-01	No Data	Low	Increased kidney & liver weight/NA	Gavage/NA	IRIS/IRIS	UF=1000(HAS)/NA
Benzene	71-43-2	Pending	Pending	NA	NA/NA	NA/NA	IRIS/IRIS	NA/NA
Chloroethane (c)	75-00-3	No Data	3E+00	NA	NA/Delayed fetal ossification	NA/Inhal.	IRIS/IRIS	NA/UF=300(HA;MF=10 for D)
1,1-Dichloroethane (d)	75-34-3	1E-01	1E-01	NA	None, under review/Kidney damage	Inhal./Inhal.	HEAST/HEAST	UF=1000(HAS)/UF=1000
1,1-Dichloroethene	75-35-4	9E-03	Pending	Medium	Liver lesions/NA	Water/NA	IRIS/IRIS	UF=1000(HAL)/NA
1,2-Dichloroethane	107-06-2	No Data	No Data	NA	NA/NA	NA/NA	IRIS/IRIS	NA/NA
cis-1,2-Dichloroethene (e)	156-59-2	1E-02	No Data	NA	Decreased hematocrit & hemoglobin/NA	Gavage/NA	HEAST/IRIS	UF=3000(HAS;MF=3)/NA
Diesel fuel or kerosene mixture	---	7E-02	2E-03	Medium	Incr. liver weight/Mild rhinitis	Gavage/Inhal.	PRC-derived (i)	UF=1000(HAS)/UF=1000(HAS)
Ethylbenzene (c)	100-41-4	1E-01	3E-01	Low	Liver, kidney toxicity/Developmental eff.	Gavage/Inhal.	IRIS/IRIS	UF=1000(HAS)/UF=300(HA;MF=10)
Methanol	67-56-1	5E-01	No Data	NA	Incr. SAP, SGPT, decr. brain weight/NA	Gavage/NA	HEAST/HEAST	UF=1000(HAS)/NA
Methylene chloride (c,f)	75-09-2	6E-02	9E-01	Medium	Liver toxicity/NA	Water/Inhal.	IRIS/HEAST	UF=100(HA)/UF=100(HA)
Methyl ethyl ketone (g,h)	78-93-3	5E-02	9E-02	NA	Fetotoxicity/CNS effects	Inhal./Inhal.	HEAST/HEAST	UF=1000(HAS)/UF=1000(HAS)
Pentachlorophenol	87-86-5	3E-02	Pending	Medium	Liver & Kidney Toxicity/NA	Diet/NA	IRIS/IRIS	UF=100(HA)/NA
Tetrachloroethene	127-18-4	1E-02	Pending	Medium	Liver toxicity/NA	Gavage/NA	IRIS/IRIS	UF=1000(HAS)/NA
Toluene (c,f)	108-88-3	2E-01	6E-01	Medium	Liver, kidney wt/CNS eye, nose effects	Gavage/Inhal.	IRIS/HEAST	UF=1000(HAS)/UF=100(HA)
1,1,1-Trichloroethane (g)	71-55-6	9E-02	3E-01	NA	Liver tox., growth retard/Liver toxicity	Inhal./Inhal.	HEAST/HEAST	UF=1000(HAS)/UF=1000(HAS)
Trichloroethene	79-01-6	Pending	Pending	NA	NA/NA	NA/NA	IRIS/IRIS	NA/NA
Vinyl chloride	75-01-4	No Data	No Data	NA	NA/NA	NA/NA	IRIS/IRIS	NA/NA
Xylenes (mixed) (c,f)	1330-20-7	2E+00	2E-01	Medium	Hyperactivity, decr. wt/Incr. mortality	Gavage/Inhal.	IRIS/HEAST	UF=100(HA)/UF=100(HA)

NOTES: CAS -- Chemical Abstract Service; RfD --Reference dose; NA -- Not available

(a) IRIS = Integrated Risk Information System (EPA, 1992); HEAST = Health Effects Assessment Summary Tables - Annual FY-1991, January 1991 (EPA, 1991a).

(b) Uncertainty factors (UF), valued 10 or less each, represent combined H, A, S, D, and L extrapolations: H = Variation in human sensitivity; A = Animal to human extrapolation; D = Lack of toxicity studies in a second species and developmental or reproductive studies; S = Extrapolation from subchronic to chronic No Observable Adverse Effect Level (NOAEL); L = Extrapolation from Lowest Observable Adverse Effect Level (LOAEL) to NOAEL. Modifying factors (MF), from 1 to 10, reflect professional judgment regarding additional uncertainties in the study and entire database.

(c) When inhalation RfDs were not reported, inhalation reference concentrations (RfC) in mg/m<sup>3</sup> were converted to chronic daily intake by using an inhalation rate of 20 m<sup>3</sup>/day and a body weight of 70 Kg.

(d) IRIS: Oral RfD and inhalation RfC assessment is under review by an EPA work group (pending) (EPA, 1992).

(e) IRIS: Oral RfD assessment is under review by an EPA work group (pending) (EPA, 1992).

(f) IRIS: Inhalation RfC assessment is under review by an EPA work group (pending) (EPA, 1992).

(g) IRIS: Oral RfD assessment was withdrawn 08/01/91. Inhalation RfC assessment is under review by an EPA workgroup (pending) (EPA, 1992).

(h) Oral RfD was based on route-to-route extrapolation.

(i) Reference: Underground Storage Tank Characterization at the U.S. Army Reserve Center Site, Fort Shafter Flats, Hawaii - Preliminary Risk Assessment (PRC, 1992).

where:

<u>Parameter</u>	<u>Definition (unit)</u>	<u>Default Value</u>
TR	= Target excess lifetime cancer risk, unitless	10 <sup>-6</sup>
BW	= Adult body weight, in kilograms (Kg)	70 Kg
AT	= Averaging time, in years (yr)	70 yr
EF	= Exposure frequency, in days per year (d/yr)	350 d/yr
ED	= Exposure duration, in yr	30 yr
SF <sub>o</sub>	= Oral slope factor, in (mg/Kg-day) <sup>-1</sup>	chemical-specific
IR <sub>w</sub>	= Daily water ingestion rate, in liter (L)/day	2 L/d
SF <sub>i</sub>	= Inhalation slope factor, in (mg/Kg-day) <sup>-1</sup>	chemical-specific
IR <sub>a</sub>	= Daily indoor inhalation rate, in cubic meter (m <sup>3</sup> )/d	15 m <sup>3</sup> /d
K	= Volatilization factor (Andelman, 1990)	0.0005 x 1,000 L/m <sup>3</sup>

The volatilization factor (K) of 0.0005 x 1,000 L/m<sup>3</sup> was derived from the experimental study by Andelman (1990) on the volatilization of radon from household uses of water. Certain assumptions were made in deriving the K value: (1) the volume of water used in a residence for a family of four is 720 L/day, (2) the volume of the dwelling is 150,000 L, (3) the air exchange rate is 0.25 m<sup>3</sup>/hour, and (4) the average transfer efficiency weighted by water use is 50 percent.

The reduced version of equation 2-2 is as follows (EPA, 1991b):

$$\text{HBS}_{\text{gw}} = \frac{1.7\text{E-}04}{2 (\text{SF}_o) + 7.5 (\text{SF}_i)} \quad (2-3)$$

(mg/L)

where:

$$\begin{aligned} \text{SF}_o &= \text{Oral slope factor, in (mg/Kg-day)}^{-1}. \\ \text{SF}_i &= \text{Inhalation slope factor, in (mg/Kg-day)}^{-1}. \end{aligned}$$

#### Noncarcinogenic Effects

$$\text{HBS}_{\text{gw}} = \frac{\text{THI} \times \text{BW} \times \text{AT} \times 365 \text{ days/yr}}{\text{EF} \times \text{ED} \times [(1/\text{RfD}_o \times \text{IR}_w) + (1/\text{RfD}_i \times \text{IR}_a \times \text{K})]} \quad (2-4)$$

(mg/L)

where:

<u>Parameter</u>	<u>Definition (unit)</u>	<u>Default Value</u>
THI =	Target hazard index, unitless	1
BW =	Adult body weight, in Kg	70 Kg
AT =	Averaging time, in yr	30 yr
EF =	Exposure frequency, in d/yr	350 d/yr
ED =	Exposure duration, in yr	30 yr
RfD <sub>o</sub> =	Oral reference dose, in mg/Kg-day	chemical-specific
IR <sub>w</sub> =	Daily water ingestion rate, in L/day	2 L/d
RfD <sub>i</sub> =	Inhalation reference dose, in mg/Kg-day	chemical-specific
IR <sub>i</sub> =	Daily indoor inhalation rate, in m <sup>3</sup> /d	15 m <sup>3</sup> /d
K =	Volatilization factor (Andelman, 1990)	0.0005 x 1,000 L/m <sup>3</sup>

The reduced version of equation 2-4 is as follows (EPA, 1991b):

$$\text{HBS}_{\text{gw}} = \frac{73}{2/(\text{RfD}_o) + 7.5/(\text{RfD}_i)} \quad (2-5)$$

where:

RfD<sub>o</sub> = Oral chronic reference dose, in mg/Kg-day.  
RfD<sub>i</sub> = Inhalation chronic reference dose, in mg/Kg-day.

For equations 2-3 and 2-5, the term containing the route-specific toxicity value as a variable can be ignored or equated to zero if that toxicity value is not available for the chemical of interest; this problem occurs frequently in the inhalation route of exposure for noncarcinogenic effects. However, most of the chemicals that lack inhalation RfD values are carcinogens, especially the limiting chemicals (EPA, 1991b) as discussed later in this memorandum. Consequently, the stricter HBSs were selected based on the carcinogenic effects. No underestimation of health risks is expected.

Once the HBS<sub>gw</sub> were established, the Summer's leachate model (EPA, 1989a) was used to estimate the HBS<sub>i</sub> based on potential contaminant migration to the ground water. The equation used

to calculate the  $HBS_{il}$  for organic chemicals is as follows:

$$HBS_{il} = K_{oc} \times F_{oc} \times C_p \quad (2-6)$$

where:

$$\begin{aligned} HBS_{il} &= \text{Health-based standard for soil, in mg/Kg.} \\ K_{oc} &= \text{Organic carbon water partition coefficient, in L/Kg.} \\ F_{oc} &= \text{Fraction of organic carbon in the soil, assumed 2 percent (EPA, 1991b).} \\ C_p &= \text{Concentration of infiltrating leachate, in mg/L.} \end{aligned}$$

The product of " $K_{oc} \times F_{oc}$ " is equivalent to the  $K_d$  value (soil:water equilibrium partition coefficient) for organic chemicals.

The concentration of infiltrating leachate  $C_p$  can be estimated from the following equation:

$$\begin{aligned} C_p &= \frac{HBS_{gw} \times (Q_p + Q_{gw})}{Q_p} = \frac{HBS_{gw} \times (7.7 + 1,560.6)}{7.7} \quad (2-7) \\ &= 203.7 (HBS_{gw}) \end{aligned}$$

where:

$$\begin{aligned} Q_p &= \text{Volumetric flow rate of infiltration into ground-water aquifer, in cubic feet per day (ft}^3\text{/day).} \\ Q_{gw} &= \text{Volumetric flow rate of ground water underneath the contaminated area of concern, in ft}^3\text{/day.} \end{aligned}$$

$Q_p$  and  $Q_{gw}$  can be calculated using the following equations:

$$Q_p = p \times A \quad (2-8)$$

where:

- $p$  = Average precipitation rate, in ft/day =  $0.67 \text{ ft/yr} \times (1 \text{ yr}/365 \text{ days})$  (JEG, 1989).  
 $A$  = Area of the contaminated area, in  $\text{ft}^2$  =  $220 \text{ ft} \times 19 \text{ ft}$  for the combined areas DS-1, DS-2, and DS-3 (JEG, 1992).

Therefore,

$$\begin{aligned} Q_p &= 0.67 \text{ ft/yr} \times (1 \text{ yr}/365 \text{ days}) \times 220 \text{ ft} \times 19 \text{ ft} \\ &= 7.7 \text{ ft}^3/\text{day} \end{aligned} \quad (2-9)$$

And,

$$Q_{gw} = k \times i \times l \times d \quad (2-10)$$

where:

- $k$  = Hydraulic conductivity, in ft/day =  $0.079 \text{ ft/min} \times (1,440 \text{ min/day}) = 114 \text{ ft/day}$  (JEG, 1989).  
 $i$  = Hydraulic gradient, in ft/ft =  $0.004 \text{ ft/ft}$  (JEG, 1989).  
 $l$  = Length of site perpendicular to ground-water flow, or the maximized hypotenuse of the rectangular contaminated area of  $220 \text{ ft} \times 19 \text{ ft}$ , in ft =  $[(220)^2 + (19)^2]^{1/2} = 220.8 \text{ ft}$ .  
 $d$  = Aquifer thickness, in ft =  $15.5 \text{ ft}$  (JEG, 1989).

Therefore,

$$\begin{aligned} Q_{gw} &= 114 \text{ ft/day} \times 0.004 \text{ ft/ft} \times 220.8 \text{ ft} \times 15.5 \text{ ft} \\ &= 1,560.6 \text{ ft}^3/\text{day} \end{aligned} \quad (2-11)$$

Preliminary  $\text{HBS}_{gw}$  and  $\text{HBS}_{II}$  results for each COPC, based on carcinogenic and noncarcinogenic effects, are presented in Tables 3 and 4, respectively.

**TABLE 3**  
**PRELIMINARY HEALTH-BASED STANDARDS FOR SOIL BASED ON POTENTIAL**  
**CONTAMINANT MIGRATION TO GROUND WATER**  
**CARCINOGENIC EFFECTS**

Chemical	Weight-of Evidence	Oral SF 1/(mg/Kg-d)	Inhalation SF 1/(mg/Kg-d)	HBSgw (a) (mg/L)	Koc (b) (L/Kg)	HBSsl (c) (mg/Kg)
Acetone	D				2.2E+00	
Benzene	A	2.9E-02	2.9E-02	6E-04	8.3E+01	2E-01
Chloroethane	D				3.3E+01	
1,1-Dichloroethane	C	9.1E-02	ND	9E-04	3.0E+01	1E-01
1,1-Dichloroethene	C	6.0E-01	1.8E-01	7E-05	6.5E+01	2E-02
1,2-Dichloroethane	B2	9.1E-02	9.1E-02	2E-04	1.4E+01	1E-02
cis-1,2-Dichloroethene	D				4.9E+01	
Diesel or kerosene mixture	---				9.6E+02	
Ethylbenzene	D				1.1E+03	
Methanol	D				2.2E+00	
Methylene chloride	B2	7.5E-03	1.6E-03	6E-03	8.8E+00	2E-01
Methyl ethyl ketone	D				3.9E+00	
Pentachlorophenol	B2	1.2E-01	ND	7E-04	5.3E+04	2E+02
Tetrachloroethene	B2	5.1E-02	1.8E-03	1E-03	3.6E+02	2E+00
Toluene	D				2.5E+02	
1,1,1-Trichloroethane	D				1.5E+02	
Trichloroethene	B2	1.1E-02	5.6E-03	3E-03	1.3E+02	1E+00
Vinyl chloride	A	1.9E+00	2.9E-01	3E-05	8.2E+00	1E-03
Xylenes	D				2.7E+02	

NOTES: SF -- Slope factor; HBS -- Health-based standard; Blank means there are no available toxicity values

(a) HBSgw for Ground Water (mg/L) =  $1.7E-04 / 2(oSF) + 7.5(iSF)$  (EPA, 1991b), where:

oSF = Oral Slope Factor, 1/(mg/Kg-day)

iSF = Inhalation Slope Factor, 1/(mg/Kg-day)

Target Excess Cancer Risk =  $1E-06$ .

(b) EPA, 1989a. For Diesel or kerosene mixture: U.S. Department of Energy, 1989.

(c) HBSsl for Soil (mg/Kg) =  $Koc (L/Kg) * Foc * Cp (mg/L)$ , where (EPA, 1989a):

Koc = Organic Carbon Water Partition Coefficient, L/Kg

Foc = Fraction of Organic Carbon -- assumed 2 percent

Cp = Concentration of Leachate, mg/L =  $HBSgw (mg/L) * [(Qp + Qgw) / Qp] = 203.7 * HBSgw (mg/L)$ , where:

Qp = Volumetric Flow Rate of Infiltration into Ground Water, ft<sup>3</sup>/day = Precipitation Rate \* Contaminated Area  
 $= 0.67 \text{ ft/yr} * (1 \text{ yr}/365 \text{ days}) * 220 \text{ ft} * 19 \text{ ft} = 7.7 \text{ ft}^3/\text{day}$

Qgw = Volumetric Flow Rate of Ground Water Underneath the Area of Concern, ft<sup>3</sup>/day  
 $= k * i * l * d = 114 \text{ ft/day} * 0.004 \text{ ft/ft} * 220.8 \text{ ft} * 15.5 \text{ ft} = 1560.6 \text{ ft}^3/\text{day}$ , where:

k = Hydraulic Conductivity, ft/day =  $0.079 \text{ ft/min} * (1440 \text{ min/day}) = 114 \text{ ft/day}$

i = Hydraulic Gradient, ft/ft = 0.004 ft/ft

l = Length of Site Perpendicular to Flow, ft = 220.8 ft

(or the Maximized Hypotenuse of the Rectangular Contaminated Area 220 ft x 19 ft)

d = Depth of Aquifer A, ft = 15.5 ft.

**TABLE 4**  
**PRELIMINARY HEALTH-BASED STANDARDS FOR SOIL BASED ON POTENTIAL**  
**CONTAMINANT MIGRATION TO GROUND WATER**  
**NONCARCINOGENIC EFFECTS**

Chemical	Oral RfD (mg/Kg-day)	Inhalation RfD (mg/Kg-day)	HBSgw (a) (mg/L)	Koc (b) (L/Kg)	HBSsl (c) (mg/Kg)
Acetone	1E-01		4E+00	2.2E+00	3E+01
Benzene				8.3E+01	
Chloroethane		3E+00	3E+01	3.3E+01	4E+03
1,1-Dichloroethane	1E-01	1E-01	8E-01	3.0E+01	9E+01
1,1-Dichloroethene	9E-03		3E-01	6.5E+01	9E+01
1,2-Dichloroethane				1.4E+01	
cis-1,2-Dichloroethene	1E-02		4E-01	4.9E+01	7E+01
Diesel or kerosene mixture (d)	7E-02		3E+00	9.6E+02	1E+04
Ethylbenzene	1E-01	3E-01	2E+00	1.1E+03	7E+03
Methanol	5E-01		2E+01	2.2E+00	2E+02
Methylene chloride	6E-02	9E-01	2E+00	8.8E+00	6E+01
Methyl ethyl ketone	5E-02	9E-02	6E-01	3.9E+00	9E+00
Pentachlorophenol	3E-02		1E+00	5.3E+04	2E+05
Tetrachloroethene	1E-02		4E-01	3.6E+02	5E+02
Toluene	2E-01	6E-01	3E+00	2.5E+02	3E+03
1,1,1-Trichloroethane	9E-02	3E-01	2E+00	1.5E+02	1E+03
Trichloroethene				1.3E+02	
Vinyl chloride				8.2E+00	
Xylenes	2E+00	2E-01	2E+00	2.7E+02	2E+03

NOTES: RfD -- Reference dose; HBS -- Health-based standard; Blank means there are no available toxicity values

(a) HBSgw for Ground Water (mg/L) =  $73 / [(2/\text{oRfD}) + (7.5/\text{iRfD})]$  (EPA, 1991b), where:

oRfD = Oral Reference Dose, mg/Kg-day

iRfD = Inhalation Reference Dose, mg/Kg-day

Target Hazard Index = 1.

(b) EPA, 1989a. For Diesel or kerosene mixture: DOE, 1989.

(c) HBSsl for Soil (mg/Kg) =  $\text{Koc (L/Kg)} \cdot \text{Foc} \cdot \text{Cp (mg/L)}$ , where (EPA, 1989a):

Koc = Organic Carbon Water Partition Coefficient, L/Kg

Foc = Fraction of Organic Carbon -- assumed 2 percent

Cp = Concentration of Leachate, mg/L =  $\text{HBGgw (mg/L)} \cdot [(\text{Qp} + \text{Qgw}) / \text{Qp}] = 203.7 \cdot \text{HBGgw (mg/L)}$ , where:

Qp = Volumetric Flow Rate of Infiltration into Ground Water, ft<sup>3</sup>/day = Precipitation Rate \* Contaminated Area  
= 0.67 ft/yr \* (1 yr/365 days) \* 220 ft \* 19 ft = 7.7 ft<sup>3</sup>/day

Qgw = Volumetric Flow Rate of Ground Water Underneath the Area of Concern, ft<sup>3</sup>/day  
=  $k \cdot i \cdot l \cdot d = 114 \text{ ft/day} \cdot 0.004 \text{ ft/ft} \cdot 220.8 \text{ ft} \cdot 15.5 \text{ ft} = 1560.6 \text{ ft}^3/\text{day}$ , where:

k = Hydraulic Conductivity, ft/day = 0.079 ft/min \* (1440 min/day) = 114 ft/day

i = Hydraulic Gradient, ft/ft = 0.004 ft/ft

l = Length of Site Perpendicular to Flow, ft = 220.8 ft

(or the Maximized Hypotenuse of the Rectangular Contaminated Area 220 ft x 19 ft)

d = Depth of Aquifer A, ft = 15.5 ft.

(d) Reference: Underground Storage Tank Characterization at the U.S. Army Reserve Center Site, Fort Shafter Flats, Hawaii - Preliminary Risk Assessment (PRC, 1992).



### Preliminary Selected Cleanup Standards

In Table 5, final  $HBS_{gw}$  and  $HBS_{si}$  were selected for each contaminant. For chemicals with two preliminary HBSs, the value selected is the most health protective value taken from either Table 3 or Table 4. The current or proposed federal and state MCL and action levels (AL) for drinking water sources are also listed for comparison with the final  $HBS_{gw}$  in Table 5. Chemical-specific preliminary selected cleanup standards for ground water ( $SCS_{gw}$ ) were determined by EPA risk managers, based on either the final  $HBS_{gw}$  or federal/state standards (MCL or AL). These risk managers employed the following selection methodology. For chemicals that have MCL values available, the preliminary  $SCS_{gw}$  is the federal MCL or state MCL, whichever is more stringent. Final  $HBS_{gw}$  were selected as preliminary  $SCS_{gw}$  for chemicals without available MCL values. These preliminary  $SCS_{gw}$  values were used in the leachate model described above to arrive at the preliminary selected cleanup standards for soil ( $SCS_{si}$ ). The preliminary  $SCS_{gw}$  and  $SCS_{si}$  values are presented in Table 5. The equation used in calculating the preliminary  $SCS_{si}$  is as follows:

$$SCS_{si} = K_{oc} \times F_{oc} \times SCS_{gw} \times 203.7 \quad (2-12)$$

where:

- $SCS_{si}$  = Selected cleanup standard for soil, in mg/Kg.
- $K_{oc}$  = Organic carbon water partition coefficient, in L/Kg.
- $F_{oc}$  = Fraction of organic carbon in the soil, assumed 2 percent.
- $SCS_{gw}$  = Selected cleanup standard for ground water, in mg/L.

### **3.0 BASELINE CUMULATIVE HEALTH RISKS**

Because the endangerment assessment for the Jasco site (JEG, 1989) was performed before EPA's 1989 Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (RAGS) was made available to the public, risk values calculated then may not represent the reasonable maximum estimates for the site, as defined by RAGS. One of the useful applications of the preliminary HBSs is to provide the baseline cumulative health risk estimates that conform with EPA's

**TABLE 5**  
**SUMMARY OF FINAL HBS<sub>gw</sub>/HBS<sub>sl</sub>, FEDERAL/STATE MCL/AL, AND SCS<sub>gw</sub>/SCS<sub>sl</sub>**  
**BASED ON POTENTIAL CONTAMINANT MIGRATION TO GROUND WATER**

CHEMICAL (Weight-of-evidence) (a)	FINAL HBS <sub>gw</sub> (mg/L) (b)	FINAL HBS <sub>sl</sub> (mg/Kg) (c)	EPA CURRENT MCL (mg/L) (d)	EPA PROPOSED MCL (mg/L) (d)	CA STATE MCL/AL (mg/L) (d)	SCS for Gr. Water (SCS <sub>gw</sub> ) (mg/L) (e)	SCS for Soil (SCS <sub>sl</sub> ) (mg/Kg) (f)
Acetone	4	30				4	30
Benzene (A)	0.0006	0.2	0.005		0.001	0.001	0.3
Chloroethane (g)	30	4000				30	4000
1,1-Dichloroethane (C)	0.0009	0.1			0.005	0.005	0.6
1,1-Dichloroethene (C)	0.00007	0.02	0.007		0.006	0.006	2
1,2-Dichloroethane (B2)	0.0002	0.01	0.005		0.0005	0.0005	0.03
cis-1,2-Dichloroethene	0.4	70	0.07 *		0.006	0.006	1
Diesel or kerosene mixture (h)	3	10000				3	10000
Ethylbenzene	2	7000	0.7 *	0.03 Sec	0.68	0.68	3000
Methanol (h)	20	200				20	200
Methylene chloride (B2)	0.006	0.2		0.005	0.04 AL	0.005	0.2
Methyl ethyl ketone (g)	0.6	9				0.6	9
Pentachlorophenol (B2)	0.0007	200	0.001 **	0.03 Sec	0.03 AL	0.001	200
Tetrachloroethene (B2)	0.001	2	0.005 *		0.005	0.005	7
Toluene	3	3000	1 *	0.04 Sec	0.1 AL	1	1000
1,1,1-Trichloroethane	2.0	1000	0.2		0.2	0.2	100
Trichloroethene (B2)	0.003	1	0.005		0.005	0.005	3
Vinyl chloride (A) (g)	0.00003	0.001	0.002		0.0005	0.0005	0.02
Xylenes	2	2000	10 *	0.02 Sec	1.75	1.75	2000

NOTES: Blank means there are no values available.

\* -- To be effective in 7/92

\*\* -- To be effective in 12/92

MCL -- Maximum contaminant level

Sec -- Secondary

AL -- Action level

EPA -- U.S. Environmental Protection Agency

CA -- State of California

HBS -- Health-based standard

SCS -- Selected cleanup standard

(a) Final HBSs for chemicals with weight-of-evidence designation were based on carcinogenic effects. The ones without weight-of-evidence were based on noncarcinogenic effects.

(b) Final HBS<sub>gw</sub> is the most health-protective HBS for ground water, based on either carcinogenic or noncarcinogenic effects in considering the ingestion and inhalation of VOCs pathways in ground water (from Tables 3 and 4).

(c) Final HBS<sub>sl</sub> is the most health-protective HBS for soil, based on the potential contaminant migration to ground water and under the assumption that the ground water will be used for potable and domestic purposes (from Tables 3 and 4).

(d) Reference: EPA, 1991c

(e) For chemicals with MCLs available, SCS for ground water is the federal or state MCL, whichever is more stringent. For chemicals without MCLs, the SCS<sub>gw</sub> is the final HBS<sub>gw</sub>.

(f)  $SCS \text{ for soil } (SCS_{sl}) = SCS_{gw} * 203.7 * K_{oc} * F_{oc}$ .

(g) Chemical detected in ground water but not reported in soil.

(h) Chemical detected in soil but not reported in ground water.

current risk assessment guidelines used in developing the HBSs. The baseline risk is defined by EPA as the risk posed by the contamination at the site in the absence of removal or remedial action. Due to the lack of the 95th upper confidence limits of the arithmetic means, only maximum concentrations were used in estimating the baseline cumulative health risks for the residential scenarios at the Jasco site. The baseline cumulative carcinogenic risk can be calculated using the following equation:

$$\text{Cancer Risk} = \Sigma [\text{TR} \times (\text{C}_i/\text{HBS}_i)] \quad (2-13)$$

where:

TR = Target excess lifetime cancer risk, assumed  $1 \times 10^{-6}$ .  
 $\text{C}_i$  = Concentration of chemical i (mg/Kg or mg/L).  
 $\text{HBS}_i$  = Preliminary health-based standard for chemical i (mg/Kg or mg/L) based on carcinogenic effects.

The baseline cumulative noncarcinogenic hazard can be estimated using the equation below:

$$\text{Hazard Index} = \Sigma [\text{THI} \times (\text{C}_i/\text{HBS}_i)] \quad (2-14)$$

where:

THI = Target hazard index, assumed 1.  
 $\text{C}_i$  = Concentration of chemical i (mg/Kg or mg/L).  
 $\text{HBS}_i$  = Preliminary health-based standard for chemical i (mg/Kg or mg/L) based on noncarcinogenic effects.

Table 6 presents the baseline health risks posed by on-site contaminated soils based on potential contaminant migration to ground water. Under the assumption that the contaminated ground water from the shallow aquifer will be used for potable and domestic purposes, the results indicate significant carcinogenic risk (a cumulative excess cancer risk of  $2\text{E-}02$  or two in one hundred) and noncarcinogenic hazard (a cumulative hazard index of 64) to the residential populations. Overall, methylene chloride contributes nearly 90 percent of the total carcinogenic risk and 85 percent of the total noncarcinogenic hazard and is the limiting chemical, which simply means that chemical(s) that are responsible for much of the baseline risk assessment, because of either high toxicity and/or

**TABLE 6**  
**BASELINE RISKS POSED BY ON-SITE CONTAMINATED SOILS BASED ON POTENTIAL**  
**CONTAMINANT MIGRATION TO GROUND WATER**

Chemical	Maximum Concentration (MC) (mg/Kg)	Weight-of Evidence	Carcinogenic HBSs (mg/Kg) (a)	Excess Cancer Risk (b)	Relative Cancer Contribution % (c)	Noncarcinogenic HBSs (mg/Kg) (d)	Hazard Index (e)	Relative HI Contribution % (c)
Acetone	278	A	2E-01	1E-05	0.09	3E+01	8.5E+00	13.38
Benzene	3					4E+03		
Chloroethane (f)						9E+01	2.9E-01	0.45
1,1-Dichloroethane	27	C	1E-01	2E-04	1.41	9E+01	1.5E-01	0.23
1,1-Dichloroethene	13	C	2E-02	7E-04	4.39	9E+01		
1,2-Dichloroethane	3.98	B2	1E-02	4E-04	2.12			
cis-1,2-Dichloroethene	4.8					7E+01	6.6E-02	0.10
Diesel or kerosene mixture	7000					1E+04		
Ethylbenzene	170					7E+03	2.3E-02	0.04
Methanol	60					2E+02		
Methylene chloride	3400	B2	2E-01	2E-02	89.81	6E+01	5.4E+01	84.84
Methyl ethyl ketone (f)						9E+00		
Pentachlorophenol	0.2	B2	2E+02	1E-09	0.00	2E+05	8.5E-07	0.00
Tetrachloroethene	16	B2	2E+00	7E-06	0.04	5E+02	3.0E-02	0.05
Toluene	1700					3E+03	5.1E-01	0.81
1,1,1-Trichloroethane	22					1E+03	2.3E-02	0.04
Trichloroethene	490	B2	1E+00	4E-04	2.14			
Vinyl chloride (f)		A	1E-03					
Xylenes	91					2E+03	4.4E-02	0.07
<b>TOTAL RISK</b>				<b>2E-02</b>	<b>100.00</b>		<b>6.4E+01</b>	<b>100.00</b>

NOTES: Methylene chloride is the limiting chemical (EPA, 1991b).

Blank means there are no available toxicity values

(a) Carcinogenic HBSs -- Health-based standard for soil was estimated based on the potential contaminant migration to ground water and a target excess cancer risk of 1E-06 (Table 3).

(b) Excess Cancer Risk =  $1E-06 * (MC / \text{carcinogenic HBSs})$ .

(c) Relative Contribution =  $(\text{Chemical-specific Risk} / \text{Total Risk}) * 100$ .

(d) Noncarcinogenic HBSs -- Health-based standard for soil was estimated based on the potential contaminant migration to ground water and a target hazard index of 1 (Table 4).

(e) Hazard Index =  $1 * (MC / \text{noncarcinogenic HBSs})$ .

(f) Chemical was found in ground water but was not detected in soils.

presence in high concentrations at the site. Methylene chloride is a class B2 carcinogen: it has been shown to cause liver cancer in animals, but there is inadequate or no evidence of carcinogenicity in humans. The evidence for noncarcinogenic effects (liver toxicity) caused by methylene chloride was also based on animal studies.

Similarly, Table 7 presents the baseline health risks posed by existing on-site contaminated ground water under the assumption that the ground water from the shallow aquifer will be used for potable and domestic purposes. The results indicate significant carcinogenic risk (a cumulative excess cancer risk of  $4E-02$  or four in one hundred) and noncarcinogenic hazard (a cumulative hazard index of 87) to the residential populations. Overall, methylene chloride contributes 55 percent of the total carcinogenic risk and 93 percent of the total noncarcinogenic hazard and is one of the limiting chemicals for the site. In addition, 1,2-dichloroethane, also a class B2 carcinogen, contributes 32 percent of the total carcinogenic risk. The difference between the relative cancer contribution of 1,2-dichloroethane in Tables 6 and 7 may be due to the fact that the  $K_d$  value obtained from the literature is not quite representative of the site-specific  $K_d$  value.

As observed from Tables 6 and 7, health risks posed by methylene chloride and other contaminants in the on-site soil (via the ground-water pathway) and ground water differ only by a factor of less than two, indicating that leaching is a real problem at the site. Therefore, in deriving cleanup standards for the contaminated soils, the potential contaminant migration to the ground water should be considered in addition to the direct contact possibility.

#### **4.0 FINAL SELECTED CLEANUP STANDARDS FOR SOIL**

Prior to determining the final  $SCS_{gw}$  and  $SCS_{sl}$  for the COPCs, the cumulative health risks resulting from exposure to these multiple contaminants, via the ingestion of ground water and inhalation of VOCs from the ground-water pathway, were assessed. Tables 8 and 9 present the chemical-specific and cumulative excess cancer risk and noncarcinogenic hazard posed by the COPCs at their preliminary  $SCS_{sl}$  or  $SCS_{gw}$  levels, respectively. The risks posed by contaminants in the ground water and in the soil at their preliminary  $SCS_{gw}$  and  $SCS_{sl}$ , are quite comparable because the  $SCS_{sl}$  were derived from the preliminary  $SCS_{gw}$ . The chemical-specific excess cancer risk related to

**TABLE 7**  
**BASELINE RISKS POSED BY EXISTING ON-SITE CONTAMINATED GROUND WATER**

Chemical	GW Maximum Concentration (MC) (mg/L)	Weight-of Evidence	Carcinogenic HBSgw (mg/L) (a)	Excess Cancer Risk (b)	Relative Cancer Contribution % (c)	Noncarcinogenic HBSgw (mg/L) (d)	Hazard Index (e)	Relative HI Contribution % (c)
Acetone	1.8					4E+00	4.9E-01	0.57
Benzene	0.02	A	6E-04	3E-05	0.08			
Chloroethane (f)	0.18					3E+01	6.2E-03	0.01
1,1-Dichloroethane	2.2	C	9E-04	2E-03	5.71	8E-01	2.9E+00	3.30
1,1-Dichloroethene	0.17	C	7E-05	3E-03	6.18	3E-01	5.2E-01	0.60
1,2-Dichloroethane	2.58	B2	2E-04	1E-02	31.80			
cis-1,2-Dichloroethene	0.013					4E-01	3.6E-02	0.04
Diesel or kerosene mixture (g)						3E+00		
Ethylbenzene	0.057					2E+00	3.5E-02	0.04
Methanol (g)						2E+01		
Methylene chloride	142	B2	6E-03	2E-02	54.67	2E+00	8.1E+01	93.39
Methyl ethyl ketone (f)	0.15					6E-01	2.5E-01	0.29
Pentachlorophenol	0.05	B2	7E-04	7E-05	0.17	1E+00	4.6E-02	0.05
Tetrachloroethene	0.008	B2	1E-03	5E-06	0.01	4E-01	2.2E-02	0.03
Toluene	0.36					3E+00	1.1E-01	0.13
1,1,1-Trichloroethane	2.04					2E+00	1.3E+00	1.52
Trichloroethene	0.019	B2	3E-03	7E-06	0.02			
Vinyl chloride (f)	0.016	A	3E-05	6E-04	1.36			
Xylenes	0.062					2E+00	3.3E-02	0.04
<b>TOTAL RISK</b>				<b>4E-02</b>	<b>100.00</b>		<b>8.7E+01</b>	<b>100.00</b>

**NOTES:**

Methylene chloride and 1,2-dichloroethane are limiting chemicals (EPA, 1991b).

Blank means there are no available toxicity values

(a) Carcinogenic HBSgw -- Health-based standard for ground water was based on the ingestion and inhalation routes (residential RME) and a target excess cancer risk of 1E-06 (Table 3).

(b) Excess Cancer Risk =  $1E-06 * (MC / \text{carcinogenic HBSgw})$ .

(c) Relative Contribution =  $(\text{Chemical-specific Risk} / \text{Total Risk}) * 100$ .

(a) Noncarcinogenic HBSgw -- Health-based standard for ground water was based on the ingestion and inhalation routes (residential RME) and a target hazard index of 1 (Table 4).

(e) Hazard Index =  $1 * (MC / \text{noncarcinogenic HBSgw})$ .

(f) Chemical was found in ground water but was not detected in soils.

(g) Chemical found in soils but not reported for ground water.

**TABLE 8**  
**SUMMARY OF FEDERAL/STATE MCL/AL, SELECTED CLEANUP STANDARDS, AND RELATED RISKS**  
**FOR SOIL BASED ON POTENTIAL CONTAMINANT MIGRATION TO GROUND WATER**

CHEMICAL (Weight-of Evidence) (a)	EPA Current MCL (mg/L) (b)	EPA Proposed MCL (mg/L) (b)	CA State MCL/AL (mg/L) (b)	SCS for Gr. Water (SCSgw) (mg/L) (c)	SCS for Soil (SCSsl) (mg/Kg) (d)	SCSsl- Related Cancer Risk (e)	SCSsl- Related Hazard Index (f)
<b>A. Carcinogen-MCL</b>							
Benzene (A)	0.005		0.001	0.001	0.3	1E-06	
1,1-Dichloroethane (C)			0.005	0.005	0.6	5E-06	6.4E-03
1,1-Dichloroethene (C)	0.007		0.006	0.006	2	1E-04	2.3E-02
1,2-Dichloroethane (B2)	0.005		0.0005	0.0005	0.03	3E-06	
<b>Methylene chloride (B2)</b>		<b>0.005</b>	<b>0.04</b> AL	<b>0.005</b>	<b>0.2</b>	<b>9E-07</b>	<b>3.2E-03</b>
Pentachlorophenol (B2)	0.001 **	0.03 Sec	0.03 AL	0.001	200	1E-06	8.5E-04
Tetrachloroethene (B2)	0.005 *		0.005	0.005	7	3E-06	1.3E-02
Trichloroethene (B2)	0.005		0.005	0.005	3	2E-06	
Vinyl chloride (A) (g)	0.002		0.0005	0.0005	0.02	2E-05	
<b>A. SUBTOTAL (h)</b>						2E-04	4.6E-02
<b>B. Noncarcinogen-MCL (i)</b>							
cis-1,2-Dichloroethene	0.07 *		0.006	0.006	1		1.4E-02
Ethylbenzene	0.7 *	0.03 Sec	0.68	0.68	3000		4.1E-01
Toluene	1 *	0.04 Sec	0.1 AL	1	1000		3.0E-01
1,1,1-Trichloroethane	0.2		0.2	0.2	100		1.0E-01
Xylenes	10 *	0.02 Sec	1.75	1.75	2000		9.7E-01
<b>B. SUBTOTAL</b>						0E+00	1.8E+00
<b>C. Noncarcinogen w/o MCL (i)</b>							
Acetone				4	30		9.2E-01
Chloroethane (g)				30	4000		1.0E+00
Diesel or kerosene mixture				3	10000		1.0E+00
Methanol				20	200		1.2E+00
Methyl ethyl ketone (g)				0.6	9		9.6E-01
<b>C. SUBTOTAL</b>						0E+00	5.1E+00
<b>CUMULATIVE TOTAL</b>						2E-04	5.2E+00

**NOTES:**

**Methylene chloride is the limiting chemical (EPA, 1991b).**

Blank means no available data

\* -- To be effective in 7/92

\*\* -- To be effective in 12/92

MCL -- Maximum contaminant level

Sec -- Secondary

AL -- Action level

EPA -- U.S. Environmental Protection Agency

CA -- State of California

SCS -- Selected Cleanup Standard (from Table 5)

(a) SCSs for chemicals with weight-of-evidence designation were based on carcinogenic effects. The ones without weight-of-evidence were based on noncarcinogenic effects.

(b) Reference: EPA, 1991c

(c) For chemicals with MCLs available, selected cleanup standards for ground water (SCSgw) is the federal or state MCL, whichever is more stringent. For chemicals without MCLs, the SCSgw is the final HBSgw (Table 5).

(d) Selected cleanup standards for soil (SCSsl) =  $SCSgw \cdot 203.7 \cdot Koc \cdot Foc$  (Table 5).

(e) SCSsl-related excess cancer risk =  $1E-06 \cdot (SCSsl/HBSsl)$ , with HBSsl based on carcinogenic effects (Table 3).

(f) SCSsl-related hazard index =  $1 \cdot (SCSsl/HBSsl)$ , with HBSsl based on noncarcinogenic effects (Table 4).

(g) Chemical detected in ground water but not reported in soil.

(h) 1,1-Dichloroethene, a class C carcinogen with equivocal carcinogenicity evidence, contributes significant excess cancer risk at its SCSsl.

(i) Chemicals that pose a cumulative significant noncarcinogenic hazard at SCSsl levels but were found at concentrations much lower than the SCSsl.

**TABLE 9**  
**SUMMARY OF FEDERAL/STATE MCL/AL, SELECTED CLEANUP STANDARDS, AND**  
**RELATED RISKS FOR GROUND WATER**

CHEMICAL (Weight-of-Evidence) (a)	EPA Current MCL (mg/L) (b)	EPA Proposed MCL (mg/L) (b)	CA State MCL/AL (mg/L) (b)	SCS for Ground Water (SCSgw) (mg/L) (c)	SCSgw- Related Cancer Risk (d)	SCSgw- Related Hazard Index (e)
<b>A. Carcinogen-MCL</b>						
Benzene (A)	0.005		0.001	0.001	2E-06	
1,1-Dichloroethane (C)			0.005	0.005	5E-06	6.5E-03
1,1-Dichloroethene (C)	0.007		0.006	0.006	9E-05	1.8E-02
1,2-Dichloroethane (B2)	0.005		0.0005	0.0005	3E-06	
<b>Methylene chloride (B2)</b>		<b>0.005</b>	<b>0.04</b> AL	<b>0.005</b>	<b>8E-07</b>	<b>2.9E-03</b>
Pentachlorophenol (B2)	0.001 **	0.03 Sec	0.03 AL	0.001	1E-06	9.1E-04
Tetrachloroethene (B2)	0.005 *		0.005	0.005	3E-06	1.4E-02
Trichloroethene (B2)	0.005		0.005	0.005	2E-06	
Vinyl chloride (A) (f)	0.002		0.0005	0.0005	2E-05	
<b>A. SUBTOTAL (g)</b>					1E-04	4.2E-02
<b>B. Noncarcinogen-MCL (h)</b>						
cis-1,2-Dichloroethene	0.07 *		0.006	0.006		1.6E-02
Ethylbenzene	0.7 *	0.03 Sec	0.68	0.68		4.2E-01
Toluene	1 *	0.04 Sec	0.1 AL	1		3.1E-01
1,1,1-Trichloroethane	0.2		0.2	0.2		1.3E-01
Xylenes	10 *	0.02 Sec	1.75	1.75		9.2E-01
<b>B. SUBTOTAL</b>					0E+00	1.8E+00
<b>C. Noncarcinogen w/o MCL (h)</b>						
Acetone				4		1.0E+00
Chloroethane (f)				30		1.0E+00
Diesel or kerosene mixture				3		1.2E+00
Methanol				20		1.1E+00
Methyl ethyl ketone (f)				0.6		1.0E+00
<b>C. SUBTOTAL</b>					0E+00	5.3E+00
<b>CUMULATIVE TOTAL</b>					1E-04	5.4E+00

**NOTES:**

**Methylene chloride is the limiting chemical (EPA, 1991b).**

Blank means no available data

\* -- To be effective in 7/92

\*\* -- To be effective in 12/92

MCL -- Maximum contaminant level

Sec -- Secondary

AL -- Action level

EPA -- U.S. Environmental Protection Agency

CA -- State of California

SCS -- Selected Cleanup Standard (from Table 5)

(a) SCSs for chemicals with weight-of-evidence designation were based on carcinogenic effects. The ones without weight-of-evidence were based on noncarcinogenic effects.

(b) Reference: EPA, 1991c

(c) For chemicals with MCLs available, selected cleanup standards for ground water (SCSgw) is the federal or state MCL, whichever is more stringent. For chemicals without MCLs, the SCSgw is the final HBSgw (Table 5).

(d) SCSgw-related excess cancer risk =  $1E-06 * (SCSgw/HBSgw)$ , with HBSgw based on carcinogenic effects (Table 3).

(e) SCSgw-related hazard index =  $1 * (SCSgw/HBSgw)$ , with HBSgw based on noncarcinogenic effects (Table 4).

(f) Chemical detected in ground water but not reported in soil.

(g) 1,1-Dichloroethene, a class C carcinogen with equivocal carcinogenicity evidence, contributes significant excess cancer risk at its SCSgw.

(h) Chemicals that pose a cumulative significant noncarcinogenic hazard at SCSgw levels, but found at concentrations much lower than the SCSgw.



the  $SCS_{il}$  or  $SCS_{gw}$  levels can be calculated using the following equation:

$$\text{Cancer Risk} = [\text{TR} \times (\text{SCS}_i/\text{HBS}_i)] \quad (2-15)$$

where:

TR	=	Target excess lifetime cancer risk, assumed $1 \times 10^{-6}$ .
$SCS_i$	=	Preliminary selected cleanup standard for chemical i (mg/Kg or mg/L).
$HBS_i$	=	Preliminary health-based standard for chemical i (mg/Kg or mg/L) based on carcinogenic effects.

The chemical-specific noncarcinogenic hazard related to the  $SCS_{il}$  or  $SCS_{gw}$  levels can be estimated using the equation below:

$$\text{Hazard Index} = [\text{THI} \times (\text{SCS}_i/\text{HBS}_i)] \quad (2-16)$$

where:

THI	=	Target hazard index, assumed 1.
$SCS_i$	=	Preliminary selected cleanup standard for chemical i (mg/Kg or mg/L).
$HBS_i$	=	Preliminary health-based standard for chemical i (mg/Kg or mg/L) based on noncarcinogenic effects.

Within each table, the COPCs were divided into three subgroups. Subgroups A and B contain carcinogens and noncarcinogens that have available federal or state MCLs. Subgroup C contains noncarcinogens without available MCLs. Chemicals in subgroup A, including the limiting chemical of methylene chloride, do not seem to pose significant cumulative health risks at their MCL or SCS levels. Only 1,1-dichloroethene (1,1-DCE), a class C carcinogen, poses an excess cancer risk of  $1E-04$ . Because of its equivocal carcinogenicity evidence (only one inhalation study was found to be positive) (Agency for Toxic Substances and Disease Registry, 1989), the numerical risk posed by 1,1-DCE may not be as serious as the number indicates and may actually be less. In fact, EPA toxicologists have recommended the use of reference dose adjusted by a factor of 10 for use in

evaluating the potential carcinogenicity of 1,1-DCE (Hiatt, 1991). In addition, the presence of limiting chemicals such as methylene chloride assures no need to further lower the preliminary SCSs derived for these individual substances for purposes of remediation. Therefore, preliminary SCSs are proposed to be final SCSs for these chemicals. Once the SCSs for methylene chloride are attained, other VOCs would typically be cleaned up to levels much lower than their corresponding health protective standards (EPA, 1991b).

Four noncarcinogens in subgroup B, ethylbenzene, toluene, 1,1,1-trichloroethane, and xylenes, pose a significant cumulative noncarcinogenic hazard (1.8) at their MCL or SCS levels. However, these chemicals were found at concentrations much lower than their MCL or SCS levels in both ground water and soil and contribute insignificantly to the baseline cumulative risks (Tables 6 and 7). Therefore, they are not expected to pose any health hazard to the public and their preliminary SCSs need not be further adjusted. This situation is also applicable to contaminants listed in subgroup C. As a results, all chemical-specific preliminary  $SCS_{gw}$  and  $SCS_{s1}$  are proposed to be the final  $SCS_{gw}$  and  $SCS_{s1}$  values in consideration of exposure to multiple contaminants via multiple pathways.

## 5.0 SUMMARY

Preliminary HBSs for COPCs in the soils at the Jasco site were developed based on the potential contaminant migration to the underlying ground water and under the assumption that the ground water is being used for potable and domestic purposes. An analytical leachate model was used in estimating the soil concentrations related to the HBSs for ground water. The final HBS for each chemical was determined to be the most health-protective value based on either carcinogenic or noncarcinogenic effects. Then, the preliminary SCSs for COPCs in the soils were derived from either the federal or state MCLs or the final ground-water HBSs. The baseline cumulative carcinogenic risk and noncarcinogenic hazard posed by the COPCs in the soils (via the ground-water pathway) and ground water were calculated. The baseline risk results indicate that soil leaching is a reality for the site and that methylene chloride is a limiting chemical in both soil and ground water. Finally, the preliminary SCSs were proposed to be final SCSs without further adjustment in considering cumulative health effects of exposure to multiple chemicals.

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## APPENDIX E

### EXPANDED EXTRACTION SYSTEM CALCULATIONS

## 1.0 INTRODUCTION

### 1.1 SCOPE OF METHODOLOGY

The methods described in this appendix were used to determine the range of extraction well systems which may be necessary to contain and treat groundwater at the JASCO site. The goal of an extraction system at the Site is to contain the flow of groundwater containing target constituents exceeding the ARARs and to direct this groundwater to extraction wells where it may be pumped from the aquifer and treated. Based upon the present distribution of target constituents in groundwater, this system should be effective at capturing groundwater passing beneath both the underground storage tank and former drainage swale areas. As the underground storage tank area is located upgradient from the former drainage swale area, the extraction system would be most effective in the vicinity of, or immediately downgradient of, the former drainage swale area.

### 1.2 DATA SOURCES

The hydrogeologic parameters used in evaluating these systems have been collected in association with aquifer testing and groundwater extraction at existing monitor well V-4. These data include results of step-drawdown and constant rate discharge aquifer tests and continuous monitoring of the pumping rate since 1987 when groundwater extraction was initiated. A submersible pump operating at a low continuous flow to limit drawdown is used to remove groundwater from the well. This groundwater is then directed through a plumbing system to the sanitary sewer system under Industrial Waste Discharge Permit 89037 as authorized by the City of Mountain View. Well V-4 was chosen for this purpose because of its proximity to the former drainage swale and its downgradient location from the production area and the underground storage tank area. This system has been in continuous operation since April 1987 with the exception of short periods of equipment maintenance.

### 1.3 OVERVIEW OF METHODOLOGY

The methodology utilized in assessing the potential extraction system design at the Site is based upon research concerning capture zones for pumping centers conducted by Javandel and Tsang (1986), Keeley (1984) and Keeley and Tsang (1983).

Given an homogeneous and isotropic aquifer of uniform thickness, a pumping well penetrating the full thickness will form a cone-shaped depression of the groundwater surface. Groundwater within this the cone of depression will be drawn to the pumping well. For a two-well system located along a line perpendicular to the direction of groundwater flow, there is a maximum separation distance such that all upgradient groundwater between the two wells will be captured by the wells and none will pass between them. A similar separation distance can be calculated for a well system consisting of any number of extraction wells. These calculations provide a method for determining the optimum number of wells and the separation distances between the wells that would be required to prevent downgradient migration past a given cross-section of the aquifer.

The following calculations should be considered only as approximations of the zone of capture. There are inherent limitations to the use of such models in the field. The accuracy of the calculations depend upon the accuracy of the estimates of aquifer characteristics. These conditions,

however, may be variable based upon changes in the potentiometric surface or volume of groundwater recharge. In addition, these models assume a laterally and vertically homogeneous aquifer consistent with hydrogeologic conditions at the pumping well. Hydrogeologic conditions in the field are rarely homogeneous.

## 2.0 CALCULATIONS

### 2.1 ASSUMPTIONS

For the purpose of providing an estimate of the effectiveness of various groundwater extraction scenarios, a number of assumptions have been made:

- 1) The A-aquifer is a homogeneous aquifer with hydrogeologic parameters as estimated at monitor well V-4 from aquifer tests conducted during previous investigations. These parameters are listed below:

A-aquifer saturated thickness (b)	= 7 feet
hydraulic conductivity (K)	= 167.4 gal/day/ft <sup>2</sup>
hydraulic gradient (dh/dl)	= 0.004 ft/ft
transmissivity (T) = (K) x (b)	= 1171.8 gal/day/ft

- 2) Maximum sustainable discharge rates from the A-aquifer range from 0.5 gallons per minute (720 gallons per day) to 2.2 gpm (3168 gallons per day). These values represent the minimum and maximum discharge rates measured at the existing extraction well V-4 over the past four years. At present the sustainable discharge rate is assumed to be 1.0 gpm based upon recent pumping rates from monitor well V-4.

- 3) The hydraulic gradient (dh/dl), based upon the historic potentiometric surface of the A-aquifer, is 0.004 ft/ft.

### 2.2 VARIABLES

The variables in solving the equation of capture zones are:

Q	=	pumping rate (gal/day)
b	=	saturated thickness of aquifer (ft)
n	=	effective porosity
v	=	true pore velocity
K	=	hydraulic conductivity (gal/day/ft <sup>2</sup> )
dh/dl	=	hydraulic gradient (ft/ft)
T	=	transmissivity (gal/day/ft)

For clarity, pi is assumed to be equal to 3.14.

### 2.3 ZONE OF CAPTURE CALCULATIONS

The zone of capture is defined by two types of stagnation points. The downgradient stagnation point ( $r_d$ ) is the point directly downgradient of the extraction well from where groundwater is no longer drawn towards the pumping well but rather moves in the direction of regional groundwater flow. This point represents the downgradient edge of the zone of capture. The cross-gradient stagnation points ( $r_c$ ) are the two points perpendicular to the direction of groundwater flow from an extraction well from where groundwater is no longer drawn towards the well but rather moves in the regional direction of groundwater flow. These points represent the cross-gradient edges of the zone of capture.

The relationship of  $r_d$  to the aquifer variables is:

$$r_d = \frac{Q}{(2 \times \pi)(b)(n)(v)}$$

This equation can be further defined for the variables which have been measured at the Site during past investigations using the following relationships:

$$v = (K/n) \times (dh/dl) \quad \text{and} \quad K = \frac{T}{b}$$

By incorporating these relationships, the downgradient stagnation point can be estimated using:

$$r_d = \frac{Q}{(2 \times \pi)(b)(n)(K/n)(dh/dl)} \quad \text{or}$$

$$r_d = \frac{Q}{(2 \times \pi)(K)(b)(dh/dl)}$$

Solving for the downgradient stagnation point ( $r_d$ ) using the present sustainable pumping rate of 1.0 gallons per minute yields:

$$\begin{aligned} r_d(1.0) &= \frac{1440 \text{ gpd}}{(2 \times \pi)(167.4 \text{ gpd/ft})(7 \text{ ft})(0.004 \text{ ft/ft})} \\ &= 49 \text{ ft} \end{aligned}$$

The relationship of  $r_c$  to the aquifer variables is:

$$r_c = \frac{(r_d \times \pi)}{2}$$

Solving for Site conditions, using the present sustainable pumping rate of 1.0 gallons per minute yields:

$$\begin{aligned} r_c(1.0) &= (49 \text{ ft} \times \pi)/2 \\ &= 77 \text{ ft} \end{aligned}$$



Similarly, these calculations can be made using the maximum and minimum recorded pumping rates from extraction well V-4.

At the maximum pumping rate of 2.2 gallons per minute, the downgradient and cross-gradient stagnation points are calculated to be:

$$\begin{aligned}r_d(2.2) &= 108 \text{ feet} \\r_c(2.2) &= 169 \text{ feet}\end{aligned}$$

At the minimum pumping rate of 0.5 gallons per minute, the downgradient and cross-gradient stagnation points are calculated to be:

$$\begin{aligned}r_d(0.5) &= 24 \text{ feet} \\r_c(0.5) &= 38 \text{ feet}\end{aligned}$$

## 2.4 SEPARATION DISTANCES

In an extraction system consisting of two extraction wells located along a line perpendicular to the direction of groundwater flow, the optimum distance between the two wells ( $d_2$ ) can be calculated by:

$$d_2 = \frac{Q}{(\pi)(K)(b)(dh/dl)}$$

The optimum separation between two wells pumping at the minimum rate of 0.5 gpm is:

$$\begin{aligned}d_2(0.5) &= \frac{720 \text{ gpd}}{(\pi)(167.4 \text{ gpd/ft})(7 \text{ ft})(0.004 \text{ ft/ft})} \\&= 49 \text{ ft}\end{aligned}$$

Similarly the optimum separation distance between two wells pumping at the present rate of 1.0 gpm and the maximum rate of 2.2 gpm are:

$$\begin{aligned}d_2(1.0) &= 98 \text{ ft} \\d_2(2.2) &= 215 \text{ ft}\end{aligned}$$

In an extraction system consisting of three extraction wells, the optimum distance between each well pair ( $d_3$ ) is approximately 1.25 times the value of  $d_2$ . Using this relationship the optimum distances between each of three wells pumping at the minimum, present and maximum pumping rates are:

$$\begin{aligned}d_3(0.5) &= 61 \text{ ft} \\d_3(1.0) &= 123 \text{ ft} \\d_3(2.2) &= 269 \text{ ft}\end{aligned}$$

### 3.0 POTENTIAL EXTRACTION SYSTEM DESIGNS

The goal of the groundwater extraction system is to extract that portion of the groundwater which contains target constituents in excess of ARARs and to prevent the downgradient migration of target constituents. The center of the present plume of target constituents in groundwater is essentially at the location of present extraction well V-4 in the former drainage swale. Since this well is located almost directly downgradient from the underground storage tank area, an extraction system designed to capture groundwater from the former drainage swale area should also be effective at capturing groundwater which has passed beneath the underground storage tank area.

Groundwater contamination is believed to be limited to the portion of the former drainage swale at the northwestern boundary of the Site. Monitor well V-5, located at the northeastern corner of the Site approximately 150 feet cross-gradient from well V-4, does not contain target constituents at detectable concentrations. Soil samples collected from near surface depths to the west of well V-4 contained elevated levels of target constituents, however, soil samples collected to the depth of groundwater at a point approximately 150 feet west of well V-4 did not contain target constituents at detectable levels.

The optimum extraction well system would contain and extract groundwater across an approximately 100 to 150 foot wide cross-section of the aquifer centered at well V-4. A system with a shorter cross-gradient zone of capture may allow downgradient migration of target constituents. A system with a longer cross-gradient zone of capture may draw in excessive amounts of uncontaminated water thus limiting the effectiveness of any associated treatment system.

The discussions of potential extraction well designs will be divided by system size (i.e. one-well, two-well and three-well systems). The maximum sustainable pumping rate will likely be the dominant factor in determining the effectiveness of extraction at achieving the plume containment goal.

#### 3.1 ONE-WELL EXTRACTION SYSTEM

As well V-4 is located near the center of the present plume of target constituents and is currently utilized for groundwater extraction, the one-well extraction system could be operated without the installation of additional wells.

At the present sustainable pumping rate of 1.0 gallons per minute, the value of  $r_c$  is estimated at 77 feet. At this rate, the present extraction well V-4 is capable of containing groundwater along a 150 foot wide cross-section of the A-aquifer centered at the center of the plume of target constituents (Figure D-1). Such a system should be sufficient to contain and extract the present plume of target constituents in groundwater.

At the minimum rate of 0.5 gpm, the effectiveness of the one-well system would be reduced to approximately 75 feet (Figure D-1). This system would be capable of extracting the groundwater containing the greatest quantity of target constituents but may not be effective at containing the full width of the target constituent plume. Periods of such low pumping rate have been limited to severe drought conditions.

At the maximum rate of 2.2 gpm, the one-well system should be able to contain groundwater along a cross-section of the A-aquifer exceeding 300 feet (Figure D-1). This system would be capable of containing groundwater flow in the direction of groundwater flow across the entire length of the former drainage swale area and the northern property boundary of the Site and would likely extract a significant quantity of uncontaminated groundwater. To prevent this occurrence, flow could be restricted to limit the recovery of uncontaminated groundwater while continuing to contain the full width of the target constituent plume.

### 3.2 TWO-WELL EXTRACTION SYSTEM

Because of the limited extent of the plume of target constituents in A-aquifer groundwater, a two-well extraction system would be feasible only under maximum sustainable discharge rates of less than 1.0 gpm. At higher discharge rates, the two-well system would recover a significant volume of uncontaminated groundwater. At the minimum pumping rate of 0.5 gpm the optimum separation distance would be 49 feet and the system would be capable of containing and extracting groundwater along a 125 foot cross-section of the A-aquifer (Figure D-2). Allowing the system to pump at a higher discharge rate such as the present 1.0 gpm would result in interference between the pumping centers and a decrease in extraction efficiency. Such a system would be most effective when maintained at the lower pumping rate.

Designing the system for a flow rate of 1.0 gpm or greater would require a separation distance of over 100 feet. While this system could easily contain the full width of the target constituent plume, it would also extract a significant volume of uncontaminated groundwater. In addition, if flow rates were to decrease the system may not be able to prevent groundwater containing target constituents from migrating downgradient between the two wells.

### 3.3 THREE-WELL EXTRACTION SYSTEM

The three-well extraction system discussed here assumes that the wells would be located along a line perpendicular to the direction of groundwater flow with the middle well located at existing well V-4. Considering the size of the plume of target constituents and the facility constraints (e.g. Southern Pacific (SP) rail lines), this configuration is assumed to be the most feasible three well configuration.

As with the two-well system, a three-well extraction system at the Site would be feasible only under low pumping conditions. At the minimum pumping rate of 0.5 gpm the optimum separation distance would be 61 feet and the system would be capable of containing and extracting groundwater along a 200 foot cross-section of the A-aquifer (Figure D-3). Even at this low pumping rate, the system would likely extract a significant volume of uncontaminated groundwater from outside of the plume of target constituents. Allowing the system to pump at a higher discharge rate such as the present 1.0 gpm would result in interference between the pumping centers and a decrease in extraction efficiency. Such a system would be most effective when maintained at the lower pumping rate.

### 3.4 EXTRACTION SYSTEMS OF FOUR OR MORE WELLS

During the evaluation of potential extraction systems a number of other configurations were considered. Among these were linear systems of greater than three wells and systems with non-linear configurations.

No linear systems consisting of greater than three wells were found to be feasible. Considering the optimum separation distances, such systems would require placement of extraction wells at locations where groundwater is known to be uncontaminated. Even at the lowest pumping rates, these systems would extract a significant volume of uncontaminated groundwater.

While multiple-well systems placed in circular or other non-linear configurations are common in the control of contaminant plumes, none were found to be feasible under Site conditions. The plume of groundwater containing target constituents is limited to a relatively small area of the Site. Such systems would not be feasible because: 1) they may result in the separation of the plume into smaller plumes which would be more difficult to recover; 2) they may result in the extraction of uncontaminated groundwater; and 3) they could require the construction of piping and associated features that could impact the SP rail lines.

#### 4.0 CONCLUSIONS

Based upon existing hydrogeologic data and the models for calculating the zone of capture of various extraction well systems, the most feasible system under the present maximum sustainable pumping rate would be a single well extraction system at existing well V-4. Such a system would be capable of both containing the plume of target constituents in groundwater and extracting groundwater containing target constituents in excess of ARARs.

Should maximum pumping rates continue to be variable at the Site, a two- or three-well extraction system may also be feasible. Such a system could be maintained at a lower discharge rate that would be less affected by variations in aquifer conditions.

Additional evaluation of potential extraction system configurations should be conducted during the remedial design stage. These evaluations should be based upon the most recent hydrogeologic and pumping rate data to ensure the most effective choice of system configuration. As any remedial actions concerning the soil within the former drainage swale area will impact groundwater quality, a decision of extraction system necessity and scope would be best made after the effects of soil remediation have been realized. Not doing so may result in the construction of unnecessary extraction wells and treatment facilities.

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